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Soil Conditions in the Irwin Canal Area.

BY

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The Maddur Channel Tract.

Introductory :—A huge artificial reservoir called the Krishnaraja Sagara, after the present Maharaja of Mysore, has recently been formed by constructing a masonry dam across the river Cauvery, and the high level canal from it is called the Irwin Canal, after the present Viceroy of India.

The canal is designed to carry water sufficient to irrigate about 1,20,000 acres of land, of which 40,000 acres may be under a monsoon crop like paddy requiring a continuous supply of water, 40,000 acres under a dry crop requiring a supply of water only once in 20 days to supplement any deficiency in rainfall, and the remaining 40,000 acres under any crop requiring an intermittent irrigation of once in 10 days throughout the year.

After running for about $24\frac{1}{2}$ miles in deep open cutting, the canal enters a tunnel of nearly $1\frac{3}{4}$ miles in length. The deepest part of the tunnel is about 140 feet below ground level. A mile or so after leaving the tunnel, the canal divides off into 2 branches, one called the Maddur Branch and the other the Cauvery Branch.

The Maddur Branch of the Irwin Canal has a total length of about 36 miles, and passes mostly through the taluk of Mandya. It is only at its tail-end that it irrigates some lands of the Malavalli taluk. Being a contour channel during the first 15 miles of its length, it can irrigate lands on only one side of it, and throughout the remaining part of its length, it can irrigate lands on both sides. As at present designed, it contains 42 sluices of different capacities capable of irrigating from 75 to 3,200 acres of land.

Out of 46,000 acres commanded by it, the Maddur Branch is designed to irrigate only 27,000 acres during a period of 7 months, *i.e.*, from about the middle of June to the middle of January or 168 days of irrigation in all. Its carrying capacity is so designed that during the irrigation season, it can supply water continuously to 9,000 acres of paddy, to 9,000 acres of dry crops once in 20 days, and to 9,000 acres of sugarcane or some other crop once in 10 days, or alternatively to about 18,000 acres of paddy and 9,000 acres of dry crops only. During summer months it can conveniently supply water to about 9,000 acres of land for irrigating sugarcane or any other crop, once in 10 days.

Soil Survey Work:—With a view to spreading the benefits of irrigation over as large a tract as possible and bringing benefit to the largest number of people as well, a system of irrigation based on a rotation of crops is contemplated. To decide upon a suitable system of rotation of crops and make the best possible use of irrigation water brought to the tract at great expense, soil survey was undertaken to study the depth and nature of soil and subsoil to a depth of 3 feet wherever possible, and locate the areas of alkali formation.

After visiting representative areas in different parts of the tract from 6th to 15th December 1929, detailed work was started from 16th December 1929.

The method of work followed has been to put down a borehole for every 15 or 20 acres of land. It is attempted to bore down to a depth of 3 feet wherever possible, take out a core of soil for a depth of every 6 inches for examination of its texture on the spot, and collect representative samples of surface soil down to 6 inches in depth for chemical and mechanical analysis in the laboratory. Just to keep a permanent record of typical soil sections down to a depth of 3 feet, representative cores bored out for the purpose have been

collected and preserved. Maps on a scale of 8 inches to a mile or representing 10 acres of land for every square inch, have been supplied by the irrigation department and the position of every borehole has been marked on the maps. Any incidental error of judgment in selecting a spot for putting down a borehole, applies to 15 or 20 acres of land of which the soil from that borehole is taken as representative.

Taking the nature of the country into consideration lands under each sluice or distributary are grouped into blocks, and soil survey work under each distributary has also been done block by block. As every block of land has generally got 2 slopes—a gentle one in the direction of and a sharp one across the distributary line—borings are so located as to get an idea of the nature of the soil along both the slopes. Where the block has sufficient width, one set of borings is taken quite close to the distributary line, a second set furthest away from it and nearest to the valley line, and a third set of borings between these two situations. Where the block is only a narrow strip of land only one set of borings is taken in the middle of the block parallel to the distributary line. As the blocks have generally more length than width, the boreholes are 3 to 400 yards apart along the length of a block and about 200 yards apart along its width.

Geological features of the tract :—As observed by the Field Geologist, Mr. M. B. Ramachandra Rao, the area under report is a narrow strip of undulating country with long and gently sloping ridges. These ridges are disposed in a N.-S. direction generally, with slopes on either side. The drainage system more or less closely follows the intervening valley between the ridges. The Hebbahalla which flows in a general N.-W. and S.-E. direction forms the southern boundary of the tract. This water course is fed by the smaller tributary streams flowing in the valleys. The east and west water course which drains into the Maddur tank, forms the northern boundary. On the eastern side, the Shimsha river forms the limiting valley and this river is practically the recipient of all the natural drainage of the area.

The general level of the country is well over 2,100 feet above the sea level. The highest point is the Satnur Hill Δ 2344, standing about a 100 feet above the general level of the country and this is the only hill in all the areas.

The principal country rock is a gneissic complex with numerous patches of hornblende schist. The gneiss is variable both in

composition and texture. The following types of gneiss have been differentiated and mapped :—1. Dark Grey Biotitic Gneiss. 2. Pale Grey and Pinkish Gneiss. 3. Dark Biotitic and Hornblendic Crumpled Gneiss. 4. Dark Grey Mylonitic Gneiss. 5. Crushed Pink Granite.

The five types mentioned above with their Pegmatite and Quartz veins and reefs constitute the Gneissic complex.

Occurring as inclusions or patches in the Gneissic complex the following rock types are found :—1. Dark Speckled Hornblende Schist ; 2. Diorite Schist ; 3. Amphibolites ; 4. Ferruginous-Quartzite.

Dyke Rocks :—Numerous runs of Dolerite are found all over the area. It occurs as spheroidal and bouldery masses and presents a prominent feature in the topography. Only one run of Pink Felspar Porphyry is found in the area, and it runs E.N.E. dipping northwards at 50 or 60 degrees for a length of about a mile.

General nature of soils in the tract :—In all, about 1,500 boreholes have been put down and 9,000 soil cores bored out for field examination on the spot. The cores examined show an enormous variation both as regards surface soil as well as subsoil. Reserving a technical description of the various soil types or series to be dealt with in a special publication to be taken on hand in due course, it may generally be said that all the soils belong to the order of what are called Mineral soils in their origin. With regard to their mode of formation, they may be designated as Sedentary or Primary or Residual soils, *i.e.*, soils formed from the underlying rock and remaining at their place of origin. Here and there, a few stretches of Transported or Secondary soils are met with.

The colour of soils varies from very pale yellow to light yellow in one group, from light yellow to light red in another, from light red to deep red in a third, and from light grey to dark grey in a fourth group.

The texture of surface soils down to 6 inches, varies from stony to sandy and loamy in the pale yellow to light red groups, from loamy to sticky in the light red to deep red group, and from loamy to clayey in the grey soil group. The stickiness in red soils does not seem to be due to clay but to a large amount of colloidal iron oxide. Such soils usually bake hard, like cement, on drying up and when such sticky material is found in the subsoil region, plant-roots may be

killed even during a short period of drought. In some areas, a very large amount of iron concretions is present in the surface soil as well as subsoil.

The presence or absence of lime in 'kankar' form differentiates the subsoils into 2 main classes. The subsoils in which lime is generally absent are either gritty, gravelly, stony, loamy, or sticky in their nature. In a large number of cases, decomposing or disintegrated rock material is met with at depths varying from 2 to 3 feet.

Lime is found in subsoils either in the form of very fine concretions or as big 'kankar' nodules. Such subsoils are generally clayey in their nature and are more than 3 feet in depth.

Pale yellow to deep red surface soils are generally associated with subsoils free from lime. Clay subsoils containing lime generally underlie grey surface soils. In a few instances, grey soils are found over red soils and *vice versa*.

Grey soils are generally found near to the valley lines and water courses and furthest away from the distributary or ridge lines. Nearest to the channel itself, the soil is generally shallow with a stony subsoil. There is alkali or 'choulu' present at the margins of tanks and almost all along the water courses, and samples of subsoils in the grey soil areas generally have a soapy feeling to the touch. To get rid of the alkali present in the soil and to prevent its further rise to the surface by irrigation, it may be necessary to provide the areas concerned with an efficient drainage system.

All these variations provide the soil scientist with ample problems to speculate upon the theories of soil formation. Another set of problems may be found in establishing a relationship between surface soil and rock down below. The problems get complicated further by the presence of dyke rocks which are mostly dolerites, and it would be interesting to find out their influence in altering the nature of soils.

The presence of a stony layer in the subsoil just like road metal spread out, is a phase of soil formation interesting to the geologist.

After reducing all kinds of soils met with along with their corresponding subsoils to a few definite series or types, the area will be mapped out according to international methods.

Chemical composition of soils in the tract :—In all, 121 samples of soils have been collected and analysed. Of these, 35 are grey

soils, 4 belong to the clay type and the remaining 82 range from light yellow to deep red in colour.

The nitrogen content of the soils varies from .013 to .07% and very few of them contain more than .05%. In a very large majority of them, it varies between .02 and .04%.

The total phosphoric acid content varies from .002 to .04% and the available or citric soluble amount of it ranges between .001 and .002%. On calculation it was found that 1.5 to 53% of the total phosphoric acid was in a citric soluble state. On closer examination of the figures, it was found that only 7 samples contained more than 25% of their phosphoric acid in a citric soluble state. According to experience in other parts of the world, soils containing less than .025% of citric soluble phosphoric acid are in urgent need of that plant food for a satisfactory production of crops. Judged from the above standard, all soils of the Maddur Channel Tract are in need of a good phosphatic manure.

The exchangeable bases, potash and lime have also been determined in all the samples. The potash content varies from .011 to .17% and the lime content ranges between .01 and 1.1%.

With an assured water supply under canal irrigation, the tract is fairly well suited for the development of sugarcane cultivation. As the presence of soluble salts in the soil beyond a certain amount is detrimental to a good growth of sugarcane, the soils have been examined for their salt content as well. All the samples examined have shown a salt content of less than .19%.

Alkali problem in the tract :—It has already been mentioned that alkali is found near the margins of tanks and almost all along the water courses. Though under the existing system of dry cultivation, the soils at present show a salt content of less than .2%, it is quite likely that under altered conditions of moisture due to introduction of irrigation, salts tend to accumulate in the soil. The field geologist has tried to mark out definitely the areas in which such an accumulation may take place.

Groundnut in Mysore.

BY

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(Concluded.)

Seed Selection :—It has been often observed by the cultivators that the quality of seeds and pods deteriorates or alters within a few years after introduction. Some of them change their seeds often to maintain the quality. I have also observed similar changes in the different varieties of seeds. The causes are many, and the deterioration is not simply due to the growing of a variety in a place for several years.

In any standard commercial sample, one can easily notice a large variation in the shape and size of pods. And the number of seeds in each pod also varies from one to two or three according to varieties. In order to find out the effect of seed selection on the uniformity of the pods produced, the effect on the vigour and the productive capacity of plants, a series of experiments was started. The pods of different varieties, like those of Mysore, Virginia, Nigeria and Mauritius, Small Japan, Valencia and Spanish, may easily be distinguished from one another. When the pods are shelled, it is not so easy to distinguish the seeds unless they vary in colour or size. Spanish, Small Japan, Virginia and Mysore seeds may be distinguished, but it is difficult to recognize the others.

Generally, in a sample of seeds one can easily recognize three grades. Some are very big, some are very small, and the others are medium in their size. As two or more seeds are found in a pod, they press one against the other and get highly compressed or deformed. It is therefore very difficult to make a study of their variation. If one-seeded pods only are shelled, a uniform sample of seeds can be easily obtained. In a pod with a single seed, the seed develops to its fullest capacity and a collection of such seeds reveals certain characteristics peculiar to each variety. A detailed study of a large number of seeds in every groundnut variety under observation was made.

Generally, the biggest and the smallest seeds are equal in number, and the number of medium seeds is as much as the other two put

together. The following Table gives the length, breadth and thickness of every grade of seed in all the varieties studied.

The measurements are too close in regard to breadth and thickness to be of any practical value. On the other hand, the measurement of length gives an index which might be useful for identification of different varieties. Taking the length of seeds in the big seeds alone, the following groupings may be formed. Where two samples are similar in length, the thickness and the breadth help to differentiate them.

	Group.	Length.	Breadth.
I.	H. G. No. 1	$15.6 \pm .04$ mm.	9.2 mm.
II.	Virginia	$14.7 \pm .035$ "	8.6 "
III.	Mysore	$14.3 \pm .043$ "	7.8 "
IV.	Big Japan	$14.1 \pm .034$ "	8.3 "
V.	(a) Transvaal	$13.8 \pm .033$ "	8.4 "
	Mauritius	$13.8 \pm .035$ "	8.3 "
	(b) Carolina	$13.7 \pm .031$ "	8.4 "
	(c) Barbados	$13.6 \pm .028$ "	8.2 "
	Sogatoor	$13.6 \pm .040$ "	8.6 "
	(d) Brazil	$13.5 \pm .023$ "	8.3 "
	Pondicherry	$13.5 \pm .036$ "	8.5 "
VI.	Small Japan	$13.0 \pm .038$ "	8.6 "
VII.	Spanish	$11.8 \pm .035$ "	9.0 "

After separating the seeds into three grades, if the weights of 100 seeds are taken they will give a good indication as to varietal character. Some varieties are decidedly heavier than the others. The weights of seeds and their lengths will, in most cases, help one to properly identify the variety.

The weight of 100 seeds and the weight of shell from 100 pods are given below :—

	Weight of 100 seeds in grammes.	Weight of shell from 100 pods.
H. G. No. 1	51.09	13.63
Virginia	46.28	13.39
Big Japan	40.76	13.15
Mauritius	40.34	11.61
Transvaal	39.98	11.33
Pondicherry	39.00	13.11

	Weight of 100 seeds in grammes.	Weight of shell from 100 pods.
Carolina	39.86	12.51
Barbados	38.24	11.17
Brazil	37.69	11.02
Small Japan	38.86	9.06
Spanish	36.71	9.45
Mysore Local	31.1	10.6

There are numerous varieties under cultivation now, and it will be shown later that every variety consists of at least four types. The number of varieties are many and it is difficult to grade the seeds. By plant selection, new and uniform types should be built up in order to secure pods and seeds of a high grade.

Size of seeds and pod-bearing capacity of plants:—The seeds of big, medium and small grades were all sown to find out the effects on production. Individual variations there were, but, on an average all of them produced the same number of pods per plant. Selection of seed according to size alone, had no effect on average production. The following Table gives the average number of pods per plant and the deviation.

GROUNDNUT EXPERIMENTS, 1926-27.

Average number of pods per plant in Plant Selections.

Variety	Big		Medium		Small	
	Average	Deviation	Average	Deviation	Average	Deviation
1. Transvaal	38.0	± 21.4	37.0	± 18.7	42.0	± 17.5
2. Local	20.3	± 3.9	15.2	± 4.6	20.5	± 12.7
3. H.G.No.1	14.3	± 7.0	14.0	± 9.7	15.6	± 10.9
4. Virginia	37.0	± 17.7	31.0	± 15.1	28.0	± 15.4
5. Pondicherry	28.0	± 15.4	30.0	± 11.4	25.0	± 10.0
6. Mauritius	33.0	± 27.0	44.0	± 30.5	60.0	± 29.5
7. Big Japan	36.0	± 32.5	33.0	± 14.4	24.0	± 7.0
8. Carolina	27.0	± 13.9	27.0	± 13.9	28.0	± 13.0
9. Brazil	25.0	± 12.3	31.0	± 12.1	25.0	± 13.3
10. Spanish	8.0	± 6.3	25.0	± 3.6	7.0	± 8.0
11. Barbados	31.0	± 12.6	26.9	± 22.1	25.0	± 10.0
12. Sogatoor	26.0	± 11.7	26.0	± 9.9	26.0	± 10.2
13. Small Japan	16.0	± 9.14	10.3	± 11.6	12.0	± 6.3
Total	339.6		329.5		338.1	
Average	26.12	± 17.7	25.34	± 12.9	26.0	± 12.1

Number of seeds in pods and effect on selections (1921):—
Some of the varieties produce a large number of three seeded

Pods. To test the effect of seed selection, six varieties were selected, and seeds from one seeded, two seeded and three seeded pods were sown in separate lines. The following figures show that there was an increase in the number of three seeded pods in plants raised from three seeds, and plants raised from one seeded pods produced mostly pods containing one or two seeds.

Variety	% of one seeded pods	% of two seeded pods	% of three seeded pods
Sogatoor—			
From parent 1 seeded pod	14	86	..
2 seeded pod	7	93	..
3 seeded pod	16	64	20
Transvaal—			
From parent 1 seeded pod	18	82	..
2 seeded pod	15	85	..
3 seeded pod	12	65	23
Carolina—			
From parent 1 seeded pod	8	92	..
2 seeded pod	6	94	..
3 seeded pod	8	63	29
Barbados—			
From parent 1 seeded pod	6	94	..
2 seeded pod	11	86	3
3 seeded pod	8	60	33
Virginia—			
From parent 1 seeded pod	23	76	1
2 seeded pod	14	86	..
3 seeded pod	13	84	3
Big Japan—			
From parent 1 seeded pod	7	86	..
2 seeded pod	19	50	31
3 seeded pod	12	58	30
Brazil—			
From parent 1 seeded pod	14	85	1
2 seeded pod	11	86	3
3 seeded pod	7	93	..

Continuous selection for two or more years showed that there was a slight increase in the percentage of three seeded pods in plants

raised from seeds of three seeded pods. Seeds from pods having one and two seeds occasionally produced three seeded pods. The following table shows that generally there is not much difference in the productive capacity of plants raised from seeds of three seeded pods, whether they were secured from one or two or three seeded pods.

Big Japan	3 seeded from	1 seeded pods	2058.0
	do.	2 " "	2058.0
	do.	3 " "	2646.0
Virginia	do.	2 " "	1764.0
	do.	3 " "	2058.0
Carolina	do.	1 " "	882.0
	do.	2 " "	2058.0
	do.	3 " "	2058.0
Barbados	do.	1 " "	2058.0
	do.	2 " "	2058.0
	do.	3 " "	2940.0
Transvaal	do.	1 " "	2058.0
	do.	2 " "	2058.0
	do.	3 " "	2058.0
Sogatoor	do.	1 " "	2205.0
	do.	2 " "	1911.0
	do.	3 " "	2058.0

When the seeds of one seeded, two seeded and three seeded pods were continually selected for 1, 2 and 3 seeds respectively and then tested the yields were in favour of 3 seeded pods.

Variety	Yield per acre in lbs.
Big Japan sown in rows 12" apart	
Seeds from 1 seeded pods	1106.4
2 " "	1383.0
3 " "	1521.3

It is therefore seen that as a practical measure it pays the cultivator to select all the three seeded pods for seed purposes. He would be gradually eliminating the inferior types producing a large percentage of one and two seeded pods and building up a high grade seed.

In the previous experiments the three seeded pods were selected from a mass of seeds and their parentage was not known. Therefore in 1926, a new set of selections were made. All the three seeded

Pods obtained by previous selections were sown, and the performance of each plant was noted separately. From these plants, three seeded pods and one seeded pods were separated.

In the next generation, plants with many three seeded pods were selected in three seeded pod selection, and plants with many one seeded pods were selected in one seeded pod selection. They were grown in 1927 and studied. Generally there is a rise in the percentage of three seeded pods in one selection and an increase in the percentage of one seeded pods in the other selection. These experiments differ from the previous ones in one respect. In the previous experiments mass selections were made, but in these experiments an attempt was made to isolate genotypes having the characters for three seeded or one seeded pods. The results suggest that it is highly necessary to weed out plants with low grade pods.

Hebbal Groundnut No. 1 (H. G. No. 1).—In 1920, a single bushy plant was observed in the plot of Big Japan. From the original bushy plant 2 pods with 4 seeds in all were obtained in 1920. In 1921 four plants were raised from them. One was erect and the other three—A, B, and C—were spreading. Subsequently the erect plant produced only erect plants and spreading plants A and C produced only spreading plants, whereas the spreading plant B always produced a few erect plants. Whenever the erect plants were isolated and grown they produced erect plants only. These erect plants which breed true were called H. G. No. 1 groundnut on the Farm. The erect plants had a dark green foliage and looked hardy. Further, unlike Small Japan and Spanish which have only one seeded and two seeded pods, these had a large number of three seeded pods.

The following figures show the difference between the H. G. No. 1 type and the two standard erect varieties :—

	No. of 3 seeded pods	No. of 2 seeded pods	No. of 1 seeded pods
Hebbal hybrid	217	456	192
Small Japan	„	13,130	4,450
Spanish	..	9,275	5,250

H. G. No. 1 :—This groundnut withstood drought very well and did not get leaf-spot disease like Spanish or Small Japan. It seems to be slightly late in ripening, by about two weeks or so,

compared with the other erect varieties. The shell of the pod is very hard, and the stalk is very long. The length of the gynophore is marked, the pods get deeper into the ground and evade the attack of crows. As the beak of a crow is shorter than the length of the stalk, the crows cannot reach them with their beaks, but only get soft earth into the mouth and nostrils if they attempt it. In the other erect varieties the pods are near the surface and are within easy reach of the crows.

Resistance to drought and the *tikka* disease (*Cercospora personata*) made the H. G. No. 1 very popular from the beginning. The seeds were tested and multiplied in summer. Tests in 1923 showed that it was quite as good as Spanish, or Small Japan. For 1924, the results were decidedly in favour of H. G. No. 1. Succeeding years have shown that it is quite superior to Spanish or Small Japan. Due to its free branching habit, H. G. 1 produces many flowers which increase the capacity for production.

In 1926, H. G. No. 1 was tested against Small Japan and Spanish in a comparatively poor field. The results were as follows. The figures are the averages of 3 plots.—

	Yield of pods per acre	
	in lbs.	
Small Japan	..	374
Spanish	..	308
H. G. No. 1	..	759

When tested against two of the best spreading varieties in the same year, 1926, the results were in favour of H. G. No. 1.

Spreading varieties	Yield of pods per acre	
	in lbs.	
Sogatoor	..	1224
Virginia	..	1296
H. G. No. 1 (erect variety) ..	..	1314

During 1927, more elaborate tests were conducted. Sogatoor was used as check or control. The end plots were sown with Sogatoor and all the varieties were repeated four times. The average yields were as follows :—

Mauritius	818.0 ± 55.7 lbs. per acre		
Sogatoor	776.0 ± 90.5	..	..
Virginia	772.7 ± 43.0	..	..

H. G. No. 1	636.0 ± 81.0 lbs. per acre
Spanish	454.2 ± 27.6 „ „
Small Japan	284.0 ± 32.3 „ „

The percentage of germination was very low for H. G. No. 1. The seeds were quite fresh and had not the same amount of rest as the others.

The following figures give the average number of pods per plant, and the weight of pods from 1000 plants.

	No. of Plants	No. of Pods	No. of Pods per plant	Dry weight of Pods	Weight of Pods for 1,000 plants
1. Mauritius	7086	60600	8.5	71.99	10.1 lbs.
2. Sogatoor	7894	64272	8.1	68.28	8.5 „
3. Virginia	6883	52900	7.6	67.98	9.8 „
4. H. G. No. 1	3901	34468	8.8	56.01	14.3 „
5. Spanish	6926	35006	5.0	39.98	5.8 „
6. Small Japan	6641	18860	2.8	24.99	3.7 „

(N.B.—Periods of drought and heavy rainfall were mainly responsible for these low yields.)

If the results are calculated taking 90,000 plants per acre as the standard number of plants for this year the following yields are obtained for every variety.

1. Mauritius	909 lbs. per acre
2. Sogatoor	765 „ „
3. Virginia	882 „ „
4. H. G. No. 1	1,287 „ „
5. Spanish	522 „ „
6. Small Japan	333 „ „

From these trials and a few trials on private farms sufficient indications have been observed to single out H. G. No. 1 as a very desirable plant for distribution. It withstands drought and *tikka* disease and produces as much as, if not more than, the reputed commercial varieties. The pods are quite as big as those of Virginia and the seeds are the heaviest of all types. The oil content is about 47% and it matures a fortnight earlier than the spreading varieties. Its defects are that it ripens later than Spanish or Small Japan, by two weeks and that it contains sometimes plants with hollow pods. By careful elimination of such plants, it is possible to get rid of such

undesirable ones. This plant has a very promising future. There were over 2,500 lbs. of this seed available for distribution in 1929. Some leading growers saw that there was money in it and readily took up the seed for multiplication. It has grown in popularity and this year there are over a couple of hundred acres under cultivation.

Fifteen years of observation on Groundnut has fully established the need for selection of plants for greater production. A need for selecting high grade seeds has been felt in other parts of the world. Two instances are worth noting in this connection as they give practical hints as to methods which should be adopted in plant selection.

W. R. Beattie in America gives the following hints (Vol. V, No. 3, page 34—*Pea-nut Promoter*, Feb. 1922).

1. The usual complaints are that varieties run out ; and
2. That new seeds are required to keep up vigour.

He says that if special care is given, for 3 or 4 years, to cultivation, to pulling out all weak plants, to selecting all the best plants for sowing year after year, in a short time a high grade of seed may be evolved. The practical hints he gives are as follows :—"Select a large number of extra good plants in the field and harvest them separately from the remainder of the crop..... Go through each plant after curing..... Keep first grade for seed patch and second grade for the bulk crop..... Next year pull out all inferiors from the seed patch..... Enough of the best seed is saved for planting the patch and the second lot is used for the bulk crop..... One half is held over as a safeguard against failure."

The above principle has been greatly elaborated by G. Nevano* in Italy and his results are very interesting and his recommendations are very definite and convincing. His suggestions are as follows :—

"Choose plants bearing the largest number of seed pods without taking into consideration their weight, or the size and number of nuts.

Correlations between the weight of the dry pods and their total number is very close.

$$(r=0.874 \pm 0.007)$$

* (*International Review of the Science and Practice of Agriculture*, New Series, 303, page 622 ; Vol II, Jan.-March, 1924. Study of correlation in the groundnut. . Nevano, G., studio di alcune correlazioni nell arachide Le Stazioni sperimentale agrarie italiane, Vol LVII, Parts 1, 2, 3, pp. 17-33, bibliography, Modena, 1924, *Arachis hypogæ*, L,

The correlations between the weight of the dry pods and their average unit weight, and between the weight of the dry pods and the number of nuts to the pod, are by no means so close, being $r=0.384 \pm 0.026$ in one case; and $r=0.217 \pm 0.028$ in the other.

There is however a close correlation ($r=0.974 \pm 0.011$) between weight of the dry pods and the weight of the plant with the fruits attached at the time it is lifted.

A similar correlation exists ($r=0.610 \pm 0.019$) between the weight of the dry pods and that of the plant without its pods at the time it is lifted. Hence the yield could be increased by choosing the heaviest plants, whether the weight of the pods is included or not. By the first method a closer correlation is obtained and the operation is also easier and quicker."

From the modes of the segregation of characters in the hybrids. I find that the first suggestion made by Nevano is very good and highly practical. The production depends not only on the vigour of the plants but also on the number of fully developed pods having seeds and the greater weight of each seed. Hence in selection not only should the plants with the largest number of seed pods be selected, but also their weights taken. The preliminary selection should be based on the selection of the plants with the largest number of seed pods and the final selection based on the biggest weight of seeds produced by each plant. A combination of these two methods will be highly useful in plant selection. Most of the commercial varieties are badly mixed with various types and within a type there is a great deal of variation. For many years to come, plant selection would be a very great factor in the improvement of the groundnut crop.

Pomegranate Cultivation in Madhugiri Taluk, Tumkur District.

BY

C. B. Krishnamurthy,

Head-master, Agricultural School, Hassan.

An area of nearly 600 sq. miles occupying the north-east portion of the Tumkur district comprises this taluk. There is a lofty chain of mountains traversing from north to south. The valleys to the south and west of Madhugiri have a greater elevation and the open country to north-east is watered by the Northern Pennar and its tributaries.

the Kumudvathi and Jayamangali. This is a very fertile tract of country with good springs in wells and *talapariges* or springheads in sandy rivers. Water is available a few feet below the surface. The soil is fertile and the area owes its prosperity to the unfailing supply of water for irrigation even in the worst of seasons. The country smiles with gardens and paddy fields. It is therefore not surprising to see at least a few kinds of fruits on the market even in years of adverse seasonal conditions. The place has been always famous for its pomegranates and there are some very good orchards in the taluk.

Seasonal Conditions.—The average yearly rainfall for 25 years is 19.6 inches. The first four months in the year are dry. The summer is hot but the area receives the benefits of both the monsoons. October is the most rainy month. The distribution is as follows :—

January	0.04	July	2.19
February	0.02	August	2.75
March	0.25	September	3.02
April	0.55	October	4.22
May	2.20	November	1.60
June	2.15	December	0.37

Soil.—The land best suited for the cultivation of pomegranates is red loam. It could also be successfully grown on good loamy soils. Proper drainage is essential as it never tolerates stagnation of water.

Preparation of land.—The land is dug well to a depth of one to two feet. Thirty cart-loads of silt, fresh earth and ant-hill soil mixed with 10 cart-loads of cattle manure per acre are evenly spread over the land and well incorporated into the soil.

Usually pits are dug a cubic yard in size at a distance of 6—8 yards apart. About 100 pits are required per acre. They are exposed for about 2 to 3 months when they are filled up with a compost of sheep manure, red earth and ant-hill or fresh soils in equal proportions.

Nursery.—A portion of the land thus prepared is selected for the nursery. A fine tilth is necessary for the sowing of the seeds. A well ripened fruit is selected from a middle aged tree. It is cut open and the seeds dried in the sun for about a fortnight. They are thinly broadcasted in the nursery beds and are then lightly covered up with a layer of manure and soil. Cattle manure and sheep manure

are liberally used for the seed beds. Watering is done every other day regularly and a dose of manure is applied at an interval of three months to facilitate good growth of seedlings. The seedlings remain in the nursery for one year from *Mungar* to *Mungar*, that is, April to April.

Planting.—Planting is usually done during the beginning of S.-W. Monsoon *i.e.*, during *Aridra* rains. The seedlings are carefully removed from the nursery beds and transplanted in the pits got ready for the purpose.

Irrigation.—Irrigation is either by hand-watering or lift irrigation which is here usually by a *kapile* (skin buckets). Irrigations are given once in three days depending upon the moisture in the soil. After the plants are two-year old irrigation is given once in every ten days during summer. On an average there will be about 24 irrigations in a year at a cost not exceeding Rs. 40.

Time of Flowering.—Every year during *Aridra* rains (middle of June) the plants after they are four-year old begin to flower. The fruits will be ready for harvest in about three months after flowering and the plants continue to yield during the next two months, *i.e.*, till *Aslesha* rains or August. The trees will be in flower for the second time in *Anuradha* (middle of November) rains and will bear fruits till the end of *Rohini* (May and June) and *Mrigasira* (June) rains. The success of the second crop depends mostly on the character of treatment given to the plants by way of frequent irrigations and liberal manuring.

Yield.—The plants begin to bear fruits from about the fourth year and continue to bear for a period of 20 years. The yield during the fourth year is from 20 to 40 fruits, in the 5th year about 100 and from the 6th year onwards up to 15th year about 200-300 fruits per plant. From the 15th year onwards the yield gradually goes down till about the 20th year when the yields begin to fall.

Pruning.—All dead, damaged and diseased portions of the tree are completely cut and removed and the cut portions are replaced by healthy shoots in a year. By periodical pruning the trees are kept quite healthy. Pruning improves the quality and quantity of fruits and the trees live for a considerably longer period.

Propagation by layering.—Pomegranate plants are also propagated by means of layering. For the purpose of layering, trees of 10-15

years standing which possess healthy branches of considerable length are selected. Lateral branches are removed and an incision is made beneath a node in a well-ripened portion which is then bent down into the soil 3"-4" deep, or into pots filled with soil. The layered shoots are kept in position by means of pegs, covered with soil and are given a good watering. In about 6 months the layered branches strike roots when they can be completely severed from the parent plant. They are left in their positions for a further period of three months or so after which they are transplanted into pits during *Aridra* (June) rains. The layered plants begin to bear fruits after they are three-year old. The fruits obtained from these plants are said to be of good size, attractive in colour, very delicious and are readily sold in the market. Plants propagated by layering are sold for from ten annas to a rupee per plant according to the demand.

Pests.—The chief pests that considerably damage the fruits are rats, *vudutes* and squirrels, amongst animals, parrots amongst birds and a caterpillar amongst insects. The estimated loss through these pests is nothing less than 25% of the total yield. Of the two crops the summer crop is severely subject to these as there is no other cultivated crop then in the adjacent lands.

Marketing.—The fruits find a ready sale in the local markets. The rate varies from Re. 0 8 0 to 1 8 0 per dozen. If purchased in hundreds, rates vary from Rs. 5 to Rs. 8. It has been the practice to cart these to Bangalore every year. Each cart is loaded with 2,500 fruits of average size. The cart hire paid is Rs. 12 to Bangalore. There the fruits are graded and sold between Rs. 3 to Rs 10 per hundred. The fruits are sent to outside places also. The average rate may be taken as Rs. 4 per hundred.

Cost of Cultivation : first year.—

4 ploughings @ Rs. 2 each	Rs. A. P.
	8 0 0

Cost of digging and filling up 100 pits

at 0-8-0 each	50 0 0
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100 plants at Re. 1 each	100 0 0
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(This includes the cost of nursery)

Irrigation, twice a week for one year	75 0 0
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Fencing and watching	67 0 0
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TOTAL	300 0 0
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<i>Second and four subsequent years.—</i>		Rs. A. P.
Digging the land		20 0 0
Manure 10 cart-loads		10 0 0
Irrigation		40 0 0
Repairing the fence		10 0 0
	Per year	80 0 0
	For 5 years	400 0 0
	For the first 6 years	700 0 0

Crop returns :

Fourth year's yield :—

An average of 3,000 fruits for each crop
valued on an average at Rs. 4 per 100. 240 0 0

Fifth year's yield :—

An average of 4,500 fruits for each crop
valued on an average at Rs. 4 per 100. 360 0 0

Sixth year's yield :—

An average of 6,000 fruits for each crop
valued on an average at Rs. 4 per 100. 480 0 0

For three crops 1,080 0 0

Cost of laying out and upkeep till the 6th year

when they will begin to bear well 700 0 0

Value of crops in three years 1,080 0 0

Net Profit 380 0 0

From the 7th year onwards the cost of maintaining remains at Rs. 80 and the return is about Rs. 480 giving a net profit of about Rs. 400 a year. It is customary also to sell away the crop for a fixed sum during the flowering season alone and this practice is usually called "Hasaruveni or Pachamaru".

Conclusion :— Pomegranate cultivation can be taken up with advantage by all who can invest a small capital on a small area of land and good profits realized for the outlay. As the Government is encouraging fruit cultivation by loans and other inducements this is an industry which might open a new avenue of employment to the unemployed.

CORRESPONDENCE.

OFFICE OF THE DIRECTOR OF AGRICULTURE,
Bangalore, March 2, 1931.

To

THE EDITOR,

*Journal of the Mysore Agricultural and
 Experimental Union.*

SIR,

We have on the Coffee Experimental Station a man experienced in grafting, who has been engaged in testing methods of grafting coffee and in ascertaining the conditions as to climate and season under which grafting can be successfully carried out.

A few coffee planters have expressed a desire to have one or two men trained in grafting methods on the farm. This is to inform coffee planters in general that we shall be glad to arrange for such training. Those desiring to have men trained should apply to the Manager, Coffee Experiment Station, Balehonnur.

Yours faithfully,
 LESLIE C. COLEMAN,
Director of Agriculture.

OFFICE OF THE DIRECTOR OF AGRICULTURE,
Bangalore, March 7, 1931.

To

THE EDITOR,

*The Journal of the Mysore Agricultural and
 Experimental Union.*

DEAR SIR,

During the past two or three months I have had a number of enquiries from coffee planters in regard to spraying against leaf disease and other diseases of coffee. I had hoped long ere this that we should have been able to publish a bulletin upon the spraying of coffee but unforeseen difficulties have arisen which have led to delay. I should, however, fail in my duty to the coffee industry if I did not express my views at this time.

It is, I think, quite clear that, at coffee prices which are now prevailing and which seem likely to prevail in the immediate future, coffee planters will have to scrutinize carefully each single item of expenditure in the light of probable returns from such expenditure. The relative importance of such different items, as cultivation, manuring and spraying will no doubt vary on different estates and in different coffee areas with the varying soil and climatic conditions that prevail. Most coffee planters have, I believe, fairly definite opinions on cultivation and manuring based usually on long local experience.

As regards cultivation I have nothing to say except that the needs must vary greatly on the different soil types found in our coffee areas. As regards manuring I would draw attention to the fact that up to the present our manurial experiments indicate the most satisfactory results from the use of ammonium sulphate and superphosphate as sources of nitrogen and phosphoric acid respectively while sulphate and chloride of potash seem to give about equal results as sources of potash. At the present time when a quick return on the money invested is essential it is, I believe, a great mistake to stick to such slow acting manures as bone-meal. As to oil-cakes the present price of groundnut cake is so low as to bring it into competition with ammonium sulphate especially in those areas situated fairly close to the source of supplies. Where, however, transport charges

form an important item of the cost of fertilizers I believe ammonium sulphate will still be found the more economical source of nitrogen.

If we turn to the spraying of coffee, planters in general are not nearly so well informed as they are in regard to cultivation and manuring. In the first place there is anything but a clear idea as to the reduction of yield due to such diseases as leaf disease and die-back. In the case of black-rot the reduction in yield is so directly apparent in the dropping of crop that most planters are able to form a pretty accurate estimate of their loss from it. The reduction caused by the other two diseases is much more difficult to estimate, especially is this the case with leaf disease and I have heard quite a number of planters express the view that the disease is not serious on their particular estates. When I state that spraying thoroughly carried out on coffee estates in Mysore over a series of years has, on the estimate of experienced planters, resulted in an average increase of two hundred weights per acre and that this increase is undoubtedly due largely to the control of leaf disease, some idea of the losses caused by this disease can be formed. I may say that some of these estates are situated in what is looked upon as one of the best coffee areas in Mysore where the losses from leaf disease are undoubtedly below the average. The extent to which leaf disease causes leaf fall is clearly brought out by recent observations of Mr. Mayne on the Coffee Experiment Station and on a neighbouring estate. He has found, in his first observations made shortly after the last monsoon, that sprayed trees carry, on an average, double the number of leaves that unsprayed trees carry. The effect of this on the production of crop will, I think, be obvious to any planter.

As far as I have been able to ascertain, those in Mysore who have taken to spraying as a regular practice are not likely to drop it during the present period of depression as they have been convinced that it pays even under present price conditions. It is, however, safe to say that in Mysore not ten per cent of the coffee area is being sprayed while in most other coffee districts the percentage is probably still smaller. Yet I am of opinion that in most coffee areas in South India no other one operation will yield such an early and large return on the money invested as spraying. This opinion is, however, subject to one most important qualification. Whereas the manuring of coffee is certain to produce results, if the soil requires fertilizers, even

when the manures are not applied at the most favourable time, this is not nearly so much the case with spraying. In other words, if spraying is not done at the right time it is very largely a waste of money.

The results of observations and experiments on the Coffee Experiment Station and elsewhere have shown pretty conclusively that for Mysore conditions spraying in May and early June immediately before the monsoon has a much better effect than spraying done earlier before the monsoon. It seems, moreover, doubtful if under average conditions spraying earlier than April will give an adequate return on the money spent. As to post-monsoon spraying, it must be done as soon after the monsoon as possible and here again it is doubtful if spraying much after the end of October or at the latest the middle of November will give an adequate return.

It is, I think, now generally accepted that for the control of leaf disease two sprayings a year are necessary to give anything like satisfactory control. In the case of black-rot spraying before the monsoon, if properly conducted, should give complete control. The necessity of two sprayings a year must, to many planters who have not undertaken this operation, seem a serious if not absolutely insuperable obstacle to its introduction under present conditions. We have, therefore, had to consider every possible means of reducing cost. Obviously the cost on labour cannot be greatly reduced except through a reduction in wages which has, I understand, already been decided upon in the Mysore coffee areas. However, there are few operations on coffee estates where thorough and constant supervision is more necessary to get the best results with the least expenditure of money. On an average, the cost of material used in spraying represents two-thirds of the total cost and it is obviously here, if at all, that great saving is possible. Experiments in this connection which have been carried out during the past year on the Coffee Experiment Station and on private estates indicate that reduction of the spray to half strength for both pre-and post-monsoon sprays does not greatly reduce the effectiveness of the control where Bordeaux mixture is used. We have not as yet carried out similar experiments with Burgundy mixture. This means that $2\frac{1}{2}$ lbs. of lime and $2\frac{1}{2}$ lbs. of copper sulphate can be used to every 50 gallons of water in place of the 5-5-50 formula commonly used now. As regards adhesives

although we have no experimental data to go upon I should be inclined under present conditions to dispense with them in the post-monsoon spray. If subsequent experience supports the tentative conclusions given above it will be possible to reduce the cost of spraying to about one and one-third that of the single spraying at full strength. If we add to this the appreciable fall in the price of copper sulphate and casein and a smaller fall in the price of lime it should, I think, be possible to carry out two sprayings for little above what a single spraying has cost heretofore. Based upon the most recent quotations received by us the cost of materials per acre, on the assumption that 400 gallons of mixture are required, works out as follows :—

		Rs. a. p.		Rs. a. p.
Pre-monsoon spray	..	7 7 0	to	9 7 0
Post-monsoon spray	..	5 15 0		5 15 0
Total for two sprays		..13 6 0	to	15 6 0

The estimated costs are based on quotations recently received and take into account railway and road transport to Chickmagalur or Saklespur—two centres from which spray materials are distributed by the Department. They may be taken as representing about what the average cost of materials would be, landed in estates in Mysore. The figures for pre-monsoon spray include cost of adhesive in the form of lime casein or resin soda, the latter increasing the cost by about Rs. 2 per acre. Linseed adhesive costs about four annas less per acre than resin soda. Notwithstanding the higher cost of these last two adhesives I would advise their use in all areas where the monsoon is at all heavy as they are more effective than casein. This seems especially necessary where a weak spray mixture is used. The cost given for the post-monsoon spray is exclusive of adhesive.

Labour charges have been usually estimated at about Rs. 7 per acre. With the lower wages that are apparently coming into force, at least in Mysore, this would be reduced to less than Rs. 6 or Rs. 12 per acre for two sprayings. The total cost for the two sprayings would therefore be between Rs. 25-6-0 and Rs. 27-6-0 per acre. If we include cost of replacements of tubing, spray nozzles, etc., the total should, I think, not exceed Rs. 30 per acre.

In the above discussion I have not mentioned the question of die-back control. While there are still a number of obscure points in connection with this disease it seems clear that spraying for the control of leaf disease will also prove fairly effective in the control of die-back but here also the time when the spraying is done and the thoroughness of the operation seem to be of great importance.

In conclusion I may say that the above tentative recommendations are based upon experiments and observations carried out in Mysore State. The climatic conditions in some other areas are different and whereas in the Shevaroyes the months of heavy rainfall differ greatly from those in Mysore, the most favourable periods for spraying will, of course, be different. I do not expect that every coffee planter will take up spraying on a large scale as a result of this communication nor would I advise it. I would, however, suggest to coffee planters in general the trial of spraying on a block of coffee, of at least ten acres in an area usually most seriously affected by disease. If the results of this test show that spraying pays under present conditions it would clearly be the point of wisdom to extend the operations as rapidly as possible. If, as is indicated by results obtained on a number of estates in Mysore, the average yield of coffee can be increased by two hundredweights per acre through spraying, surely it is wise to undertake it even under present conditions. An average increase in yield of two hundredweights per acre at a cost equivalent to less than the value of one hundredweight would, I believe, make all the difference between profit and loss on many coffee estates in South India. I may say, however, that an increase of this amount is hardly to be expected upon coffee that has been starved and neglected, for if there is insufficient plant food in the soil, the plants cannot be expected to make a vigorous growth even with spraying. On the other hand it is equally certain that manuring is of no practical value in the control of either black-rot or leaf disease. On the subject of the relation of manuring to die-back I should not like to express an opinion at present.

Yours faithfully,
 LESLIE C. COLEMAN,
Director of Agriculture.

NOTES AND COMMENTS.

Groundnut in Mysore.

The article on the subject printed in this and the previous issue of the Journal formed part of a thesis submitted by Dr. Venkata Rao K. Badami, L.Ag., Ph.D., for the degree of Doctor of Philosophy of the Cambridge University. It has been somewhat modified for the Journal by the author. We are much obliged to him for permitting us to publish the article.

* * * *

Our Annual Meeting.

The next Annual General Meeting has been arranged to be held on the 22nd and 23rd May, 1931. An interesting programme which includes discussions on Agricultural Education and the Agricultural work of Co-operative Societies in Mysore, has been drawn up. There will be the usual discussion on the work done by members during the previous year. While considerable work is done by the members the discussion at the Annual Meetings of the results of their work suffers from the fact that the members themselves are largely absent at the time. Many questions which arise during the discussions go unanswered and the reports are incomplete. Members, and particularly those who have conducted experiments under the Union's programme, are requested to attend the meeting this year and help to enhance the value of their reports by taking part in the discussions. Being practical men, their opinion on such subjects as Agricultural Education and Agricultural work of Co-operative Societies, would be very valuable indeed in the attempt to evolve schemes suitable to the conditions of the country.

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Affiliated Associations.

Rules for the affiliation of moffussil Agricultural Associations passed at the Special General Meeting held on the 15th November 1930, are published in the last page of this issue,

SELECTIONS.

India not yet Self-Supporting in Horses.

During the year 1930-31 the Government of India have found it necessary to purchase 2,621 horses from overseas for the service of the British and Indian Armies, while only 65 full-grown Indian horses and 1,200 young stock are expected to be obtainable during the same period within the country itself. The 1,200 young stock represent to a great extent the result of the Government system of the establishment of horse-breeding colonies in certain areas by grants of land for the purpose, and the 65 full-grown horses represent roughly the result of private enterprise assisted by the provision of Imperial and District Board stallions. A certain number of horses of a good stamp find their way into private hands at a figure higher than the Government price for remounts, but, even so, the number of horses produced by over three hundred million people in a country as big as Europe without Russia would be a subject for mirth if it were not so serious. It is a sad state of affairs when neither the people nor their leaders nor the wealthy landowners have the vision to see how their chances and opportunities are being neglected.—*Journal of the National Horse-Breeding Society, Delhi.—Lice Stock Journal, Vol. CXII, No. 2951.*

Loans available to Agriculturists in Uruguay.

1. Loans for the development of stock breeding.
2. Mortgage loans for the extension of agriculture, sub-division of estate, establishment of agricultural industries, cheap dwelling houses.
3. Operations of agricultural pledge.
4. Loans for the stocking of farms by means of purchases of breeding animals.
5. Special loans for purchases at fairs or auction sales in the event of selling up of farms.
6. Special loans for the establishment of factories for agricultural industries.
7. Special advance in seeds.
8. Loans for the purchase of seeds.
9. Loans for harvest expenses.
10. Loans with guarantee of cereals in deposit.

11. Loans for the purchase of machines on the basis of technical information and of the ascertainment of the possibilities of their advantageous utilization.

12. Loans for the purchase of the equipment, apparatus for dairies and creameries, for the manufacture of preserved foods, etc.

13. Current accounts with dealers in agricultural machinery, so as to facilitate sales to farmers following on circulation of the agricultural pledge documents signed by purchasers.

14. Small loans to small rural growers, to be granted to the branches of the Bank in the respective zones, the growers to be recommended by local farmers' associations.

15. Loans to rural co-operative societies and unions. For each type of society the maximum sum, the maximum duration, the rate of interest and extent of guarantee are fixed. Usually the interest is $5\frac{1}{2}$ per cent, in some cases 6 per cent.—*International Review of Agriculture*, Year XXI, No. 8.

Sterility in Cows.

BY L. S. JOSEPH, G.B.V.C.,

*Cattle Superintendent, Imperial Institute of Agricultural Research,
Pusa.*

(This note may be of practical use to cattle-owners. No attempt has been made to summarise recent research on the subject.)

The begetting of off-spring, whether in the higher or lower animal kingdom, involves two physiological processes.

First.—Ability on the part of the male to deposit healthy seminal fluid in contact with the orifice of the uterus of womb.

Secondly.—Ability on the part of the female to receive this fluid at the orifice of the uterus and such a condition of health of the uterus, fallopian tubes, and ovaries, as will enable the spermatozoa to meet and unite with a healthy ovum.

Failure in either of the two processes leads to unfruitful union and is the cause of sterility.

The subject to be considered in this note being sterility in cows, we are concerned mainly with the second process and with the various anatomical and functional defects that render a cow barren or sterile. It is however necessary before we take it for granted that the cow is at fault, that we should be in a position to affirm that the fault does not lie with the bull. We must, therefore, devote some preliminary observations to the bull's share in the responsibility for a fruitless union.

The inability on the part of the male to propagate may arise from incapacity to perform the act of coition or from incapacity to copulate fruitfully, although the accessory genital apparatus may perform its function properly, due to accidental external condition, organic diseases, deficient production of semen—"aspermia," or from absence of spermatozoa—"azoospermia".

The bull should not be allowed to be in a fat or soft condition when the time for service arrives. He needs to be in really good condition, but this should not be overdone. Stall-feeding without sufficient exercise tends to make him very fat, soft, and slack in service. The best plan, therefore, will be to keep him in an enclosure where adequate shelter is provided, and take each cow to him for service only when she is ready and, after two services, take her back to the paddock. This enables the bull to conserve his energy, instead of wasting it in unnecessary services and perhaps rendering himself temporarily useless, from time to time, if he is allowed to run with the herd, as is usually done in most of the farms. Frequent examination of the generative organs is absolutely essential. If any abnormalities are observed, they should be treated immediately.

The incapacity for the act of coition or for fertilization or germ formation in the cow may be either transient (curable) or permanent (incurable). The transitory form of sterility may arise from some diseased condition of the uterus and is curable: the other can be traced to the *absence of the ovaries* in which case it is incurable, or their atrophied condition which may prove incurable. Chronic endometritis (inflammation of the lining membrane of the uterus) often terminates in incurable sterility. Excess of acidity of the vaginal mucous secretion kills the spermatozoa in the canal and this causes a sterility which is only temporary. The injection of 0.5 per cent solution of bicarbonate of soda into the vagina neutralizes the excess of acidity and helps fertilization of the germ-cell.

In the cow the fecundations normally appear to average about 79 per cent, but when a smaller percentage is observed in a herd, the causes for such a state should be suspected to be other than organic, namely, climate, food, environment, and *failure to put the cow to the bull at the optimum time for service*. This last cause requires some comment.

In the cow the heat periods are longer in summer than in winter and some individuals tend to have very short periods of heat. Since during the winter men's working hours are short, it follows that heat periods of 6 or 10 hours only can be easily missed if they occur in the night. At this time of the year (winter months) not only are the heat

periods shorter than usual, but the symptoms are also less marked, and it is easy to overlook the fact that the cow is in season. Heat is also more difficult to detect among the larger number of cows when the animals are tied up in byres or tethered on ropes for grazing, than when the herd is grazing free, for in the latter case the cow's actions can be observed. During œstrum the cow is restless and a white glary discharge appears from the vulva, more especially after the cow has mounted others.

In addition to the ovary and testicle, the thymus and pituitary glands form secretions affecting sexual development, and the latter, or rather its posterior lobe, assists in stimulating the changes which normally occur at puberty. Hypertrophy of these glands leads to sexual precocity, while atrophy of the latter gland gives a tendency to obesity and subsequent sterility. This gland controls the development of the thyroid which has a profound effect on metabolism. Sometimes due to hypernitrogenous feeding, a condition known as hyperthyroid activity occurs in cows, which is also responsible for the cows not holding. Overfed animals generally do not breed so readily as those which are in moderate condition. In such cases an attempt should be made to reduce the condition of the cows before they are put to the bull.—*The Journal of the Central Bureau for Animal Husbandry and Dairying in India*, Vol. IV, Part II.

The Agricultural Value of Manures.

Note.—Increasing attention is nowadays being given by practical agriculturists to the possible economic value of manuring. The following abstract, stressing the need for careful field trials, is taken from the *Annual Report of the Society of Chemical Industry* on the progress of Applied Chemistry, 1927, p. 474. The original article was written by Dr. E. M. Crowther, Head of the Department of Chemistry, Rothamsted Experimental Station.—EDITOR.

The valuation and efficient use of fertilizers depend in large measure on information derived from field trials, but the art of field experimentation has not kept pace with developments in the science and practice of agriculture. It is only during the last few years that there has been any considerable improvement on the methods used throughout last century. Formerly the interest lay in showing that good crops could be grown with artificial fertilizers and in comparing these with farmyard manure. For these purposes, it was sufficient to have a single strip, or quite rarely a series of a few such strips, differing in manuring from the rest of the field. The results of a large number of these experiments extending over many years have now been embodied in general farming practice. The policy of carrying out a large series of simple field trials is

still followed for demonstration and propaganda purposes, and is sufficient to show in the course of years whether or not any treatment gives beneficial results under average conditions of soil, climate, and cropping. But such co-ordinated experiments involve a heavy expenditure of time and money, and can be used only for the simplest problems. Isolated experiments of this type are *totally inadequate for the investigation of modern fertilizer problems*. The farmer is concerned, not with the gross increase in yield to be obtained by applying a fertilizer, but with the difference between the selling value of this increment and the extra cost of growing it; in the balance, an advantage or loss of 5 per cent of the total crop will be a considerable item. There is also an urgent need for more exact information on practical details in the use of fertilizers. Thus, with a nitrogenous top-dressing for cereals questions arise as to the choice of the fertilizer, the amount of the dressing, and the time of application. In other cases, the balance of the manuring is important. Comparisons are now required between fertilizers which closely resemble one another, and the results must be obtained rapidly before changes in the economic situation have destroyed their practical value. The growing importance of these problems has directed attention to the necessity for considerable improvements in the technique of field experimentation, and some important advances have recently been made.

The prime difficulty arises from the *effects of soil heterogeneity*. Many experimenters, especially plant-breeders, attempted to minimise these effects by increasing the numbers of similarly treated plots, which were generally set out in regular geometrical patterns. The standard of accuracy was materially increased in many cases, but there was no general recognition of the standard to be attained before an experiment could be regarded as reliable. During the last few years, many important contributions to both the theoretical basis and the practical technique of field experimentation have been made. Special emphasis has been laid on the vital necessity for a valid estimate of the magnitude of the errors affecting the results. This estimate must be derived from the yields of the similarly treated plots. Systematic methods of arrangement by eliminating the elements of chance, destroy the validity of the statistical methods used in estimating the precision of the experiment. By the application of the Fisher's "analysis of variance" it has been possible to design lay-outs which reduce the actual errors due to soil irregularity, whilst still retaining sufficient elements of chance to give a valid estimate of the residual errors and the significance of the results obtained. In the "randomised block" method, which is capable of the most general application, the experimental area is divided

into a number of compact blocks equal to the number of replications desired, and within each block the treated plots are arranged wholly at random. The components of soil heterogeneity which produce differences in fertility between plots of the same block are completely randomised, while those components which produce differences in fertility between the different blocks are completely eliminated. Where the number of replications equals the number of treatments, the so-called "Latin square" experiment (with a random arrangement, subject to the restriction that each treatment occurs once in each row and each column), allows the elimination of the effects due to differences between the rows and the columns.

The accuracy of the results attained in recent fertilizer trials carried out on these lines at Rothamsted, may be illustrated by comparisons in 4×4 Latin squares of the manurial value for potatoes of three sources of potash:—

Year.	Average yield.	No Potash.	Pot. Sul- phate.	Pot. Chlo- ride.	Pot. Salts.	Stan- dard error.
1925 ..	8.37 tons per acre (=100)	60.1	115.6	112.5	111.8	2.43%
1926 ..	9.45 do. (=100)	87.3	105.0	106.4	101.3	1.91%

In 1925, there was a strong response to all potash applications, the sulphate showing some superiority; in 1926 there was only a moderate response to potash, both sulphate and chloride being superior to potash manure salts.

Experiments of these newer types are inevitably expensive, but it is greatly to be hoped that the importance of accurate information, and the magnitude of the organizations controlling fertilizers will enable increasing numbers of them to be made. The standard of field experimentation should be as rigidly controlled and as openly discussed as that of the laboratory methods of the analyst and research worker.

—*The Tropical Agriculture*, Vol. VII, No. 11.

Care of the Dairy Cow or Buffalo at Calving Time.

The cow nearing parturition should be cared for and fed in such a way that she will calve easily and normally, recover rapidly from the effects of calving and start her lactation period in good health. Proper management at this time means more living calves, fewer sick cows and

better chances for a longer period of greater milk and butter fat production.

Care before Calving.—The cow nearing parturition should be taken in hand six to eight weeks before date of calving, it must be kept with other cows in a like condition and grazed or exercised separately from the whole herd. She should be housed in a roomy box stall, about 10 ft. square is large enough, and if room permits, a small exercise yard adjoining. See that the cow does not injure herself by slipping in the stable floor, which should have rough surface, and that she does not crowd through doorways or at a water tank. If the cow due to calve is allowed to run with the herd, there is a possibility that it may mount other cows in heat and slip and injure herself: so keep her separate from the main herd. The loose box should be kept clean and disinfected and a good bedding of hay or paddy straw put on the floor in order to make the cow comfortable; in this manner she will accustom herself to her new surroundings before the time of calving. Cows nearing parturition should be given plenty of exercise and not tied up all day long. Graze her separately in a small paddock.

Wash and groom the cow frequently, handle her every day so that she gets used to you and she will be gentler and easier to milk after calving.

Feeding before Calving.—During her dry period, feed her on a maintenance ration of 3 to 4 lb. per day of a concentrated food according to her size (2 lb. groundnut cake and 2 lb. wheat bran). Six weeks before calving, increase this gradually to 6 lb. concentrated feed, 2 lb. cake, 1 lb. dholl husk, 2 lb. wheat bran, and 1 lb. rice bran *plus* 15 lb. green grass or fodder or silage and 10 lb. hay. This assists the cow to be in good condition at the time of calving. The cow is thus able to stand the strain of calving better than if she is in a weak condition. Keep the cow warm and if she is constipated, give her a bran mash (made of warm water and wheat bran), also a dose of Epsom Salts, say $\frac{3}{4}$ lb. in warm water.

Care during Calving.—Leave the cow quiet to calve naturally. Do not disturb her. Watch her condition, however, from time to time. After she has laboured an hour or two, have an examination made by an experienced person to determine whether the calf is in normal position, which is nose and front feet foremost with the front alongside the head. Usually the calf is in this position, and the cow is able to expel it without much difficulty. If the calf is not in this position, however, it can sometimes be pushed back into the womb and turned so that it may be presented normally. Before attempting this, wash the arms and hand

carefully in a disinfecting lotion and oil the hand and arm well before inserting it into the womb to explore. If it is evident, after 2 or 3 hours of straining that the cow is going to calve with difficulty, steps should be taken to help her. In order not to injure the cow, call in a Veterinary Doctor or an experienced person to attend to her at this time.

Care of the new-born Calf.—Give the calf attention as it arrives. Sometimes a slimy membrane covers its nose; remove this at once and blow down the nostrils so that the calf breathes easily. Usually the cow will dry the calf by licking it vigorously. If she does not do so, dry the calf with a wisp of hay or straw or other suitable materials. Soon the calf will attempt to rise and in half an hour it will be suckling. If it is weak and unable to stand and suckle, hold it to the cow's udder. ALWAYS give the calf the first milk (colostrum), this is very beneficial in cleaning out the system and in aiding the organs to start functioning.

To prevent navel troubles such as navel ill, etc., apply tincture of iodine to the calf's navel *immediately* after birth. If the cord attached to the navel is long, cut it off about an inch from the body after tying with a ligature above and apply iodine.

Care after Calving.—Just after calving, the cow is in a weakened condition and her digestive system is sluggish. She needs little nourishment but should be kept warm and comfortable. It is a good practice to give her a warm douche, such as Epsom Salts (12 oz.) and a little ginger and give her lukewarm water to drink. Feed her for the first day on warm bran mash (wheat bran). Thus cared for, she should be able to expel the after-birth normally within a few hours after she has calved. If it is necessary to leave the cow alone, tie her up so that she cannot reach the after-birth after it has been expelled. Remove it from the stall as soon as possible.

If the after-birth is not expelled naturally within the first 48 hours, its retention is usually due to inflammation of the womb. Call in a Veterinary Doctor and obtain his help, for it may be followed by or induce barrenness.

Milking.—The time of the first milking will depend on the condition of the udder. Usually it will not be necessary to milk the cow for about 12 hours after she has calved. And then, only part of the milk should be drawn and the rest left for the calf.

Milk fever.—Milk fever generally attacks mature cows and usually occurs within two days after calving if it does occur. It is usually heavy milkers which suffer from this and the present Indian cow is not likely to suffer from this. It may be recognized by a staggering gait and lack of control of the hind legs. As the disease progresses, the cow goes down

in a stupor, lying in a natural position, except that the head is usually turned towards the flank. Later, paralysis may become general, and then the cow lies on her side. Treatment should be given promptly and a Veterinary Doctor called in at once with a special milk fever outfit. Sterile air is pumped into the four quarters of the udder and tape tied round the teats to prevent the air from escaping for 3 hours or so. After three hours, remove the tape and massage the teats. Usually one treatment is sufficient. It is generally effective.

Congested udder.—If the cow is at all feverish or the udder hard and congested, give a douche of 1 lb. dose of Epsom Salts. If this does not have the desired effect, give a second dose later. Leaving the calf with the cow for a few days may help. The calf's frequent sucking and massaging of the cow's udder seem to aid in lessening the congestion. In persistent cases, milk the udder 3 or 4 times daily, bathe with warm water, thoroughly dry the udder and massage it and then apply camphorated oil to the affected quarters. Keep the cow indoors out of drafts.

Feeding after Calving.—Give her plenty of succulent fodder or green grass and feed her with concentrated food according to her milk yield. If giving 15 lb. milk a day, give her 8 lb. concentrated food (2 lb. cake, 2 lb. cotton seed, 2 lb. dholl husk, and 2 lb. bran). Increase this gradually if her yield increases. The cow will gradually give more milk each day up to the 5th or 6th week when she will reach her maximum and remain about that amount for a time.—*The Madras Agricultural Journal*, Vol. XIX, No. 1.

Soil Analysis.

ITS MEANING AND SIGNIFICANCE TO THE PRACTICAL AGRICULTURIST.

(*Note.*—Many practical agriculturists still believe that a chemist, merely by analysing a single soil-sample in the laboratory, is able to prescribe suitable fertilizer treatments for the soil. That this view is no longer held by agricultural chemists is a matter worthy of note by the plant grower. The following abstract of a review of the subject by Mr. H. J. Page, formerly Chief Chemist at the Rothamsted Experimental Station, and now Head of the Research Division of Messrs. Nitram, Ltd., is therefore of interest. The review appeared in the *Annual Report of the Society of Chemical Industry* on the Progress of Applied Chemistry, 1930, p. 427.—EDITOR.)

Despite the enormous amount of work that has been done on the estimation of "available plantfood" in soils, the soil chemist is unable to state with any degree of certainty, merely on the basis of a chemical examination, the manurial needs of any given soil. He is nevertheless frequently expected to do so, it being a common experience for him to

receive a sample of soil from a farmer with the request that he will analyse it and state in what respect it is deficient in plant-food and what fertilizers are needed. In practice, there is usually no difficulty in diagnosing a deficiency of *lime*, with which deficiency probably more cases of crop failure can be associated than with any other. With regard to *nitrogen*, the response to nitrogenous manures on most British agricultural soils is so definite that the benefit of such dressings at their proper places in the rotation is seldom called into question. The position is far otherwise as regards *phosphorus* and *potassium*. Practically any of the known methods will show up a soil in which the supply of either of these elements is at its lowest ebb: the difficult problem arises with soils which appear to contain at least a moderate amount of readily soluble phosphate and potash. Some such soils behave reasonably and respond to phosphatic or potassic manuring more or less as would be expected from their analysis, but soils are not infrequently met with which, on analysis, appear to contain a sufficiency, and on occasion even more than a sufficiency, of one or both of the elements in question, and which nevertheless prove in practice to be extraordinarily responsive to manuring with the fertilizers that would have been deemed unnecessary from the analytical figures. The result is that any agricultural chemist who values his reputation hesitates to give advice regarding the manuring of a soil unless he has available also the results of vegetation experiments, preferably on the field scale, on that or similar soils.

Without doubt, many cases of the failure of soil analysis to fore-cast the responsiveness of a soil to manuring may be explained by the operation of other limiting factors, the existence of which has been unsuspected or overlooked. *The realization of the complexity of the soil and of the factors which control crop production, and the increasing degree to which the mode of operation of these factors is being elucidated, enable the well-informed agricultural chemist to form an opinion as to the needs of a given soil with greater certainty than formerly.* Although it is, in the nature of things, vain to expect that any solvent or method can be found which will give in all cases a clear and direct indication of the manurial needs of the soil, it is desirable to consider the relative merits of the many methods that have been proposed for this purpose.

The oldest and best known method for the estimation of the "available" phosphate and potash in the soil is that of Dyer in which the soil is extracted with 1 per cent. citric acid. This method is the one commonly used in this country. In the United States, preference is given to the use of $\frac{N}{5}$ hydrochloric or nitric acid. On the Continent, Mitscherlich's method, depending on the use of water saturated with carbon-dioxide,

is often used. Studies of different methods have led many continental workers to conclude, however, that the Dyer method is generally the most suitable, at least as regards the estimation of "available" phosphate, but for potash, the use of mineral acids appears to be more satisfactory.

As an alternative to the analysis of the soil, that of the plant grown on the soil in question has been suggested as an obvious means of estimating how much of the nutrient material in the soil is available for plant growth. The difficulty of using full-grown plants for this method consists largely in the need of first ascertaining the composition of an average plant of the sort used in the experiment.

In a recent work by Neubauer and his colleagues in Germany, an attempt is made to get over this difficulty by growing a large number of seedling plants (rye) in a small amount of the soil under investigation so that the whole of the soil is completely penetrated by the roots. It is concluded that, after the lapse of 18 days, the whole of the readily available phosphates and potash in the soil will have been absorbed: the plants are then separated from the soil and analysed. This method gave quite promising results, and it merits further trial.

An interesting application of the use of the plant as a means of estimating the manurial needs of the soil is that developed by H. Walker for the soil of sugar plantations. The phosphate and potash in the sugar-cane juices were determined, and it was found that a content of less than 0.02 per cent. and 0.05 per cent. of P_2O_5 and K_2O respectively in the juice was an indication of the need for phosphate or potash manuring.

The ultimate criterion of the need of a given soil for manuring *must always consist of vegetation experiments in pots and in the field*, in which is determined the actual effect on crop-yield of a given fertilizer under conditions excluding the action of non-manurial limiting factors (pot experiments), and under natural conditions (field experiments). A critical experimental comparison of all the more promising of the chemical methods on a series of widely representative soils on which field and pot experiments are also carried out, is much to be desired.—*Tropical Agriculture*, Volume VII, No. 11.

Castor Plant: Its Cultivation and Utilization of Produce.

General.—The castor plant which is not cultivated on a large scale as other crops, except probably in a few patches here and there, makes its existence felt by its produce, *viz.*, the oil, which is largely used in lubricants, lighting and as a laxative. Besides these there are several other uses to which the seed and oil are put: and the industrial utilization of

the same on a large scale has given a great impetus to the cultivation of the crop, in spite of some inherent defects in its harvest. The chief difficulty lies in the fact that the crop does not often mature uniformly and such being the case it does not pay the ryot to grow on a large scale, especially in places where labour is dear. Dealing with such a crop on a co-operative basis, though grown in small patches, is really worth the trouble in view of the great demand, as the export and import figures in the sequel would indicate. It thrives in tropics and sub-tropics except in very arid regions. In temperate zones also it does well, but the summer is not sufficiently long to completely ripen the crop.

Botanical Characters.—Castor (*Ricinus communis*) belongs to the natural order Euphorbiaceæ and is widely distributed throughout the tropics. It is believed to be a native of North Africa and also probably of India. From an annual to perennial it is seen growing under varying climatic conditions and the height accordingly varies from 8 to 30 feet. The leaves have long stalks, are palmate, glaucous, green, and have serrate margins. The flowers of the two sexes are produced in terminal paniced racemes; the staminate flowers being seen at the base and the pistillate at the top. Fruit is a 3-celled, 3-sided capsule, covered with spiny prominences. The seeds are oval, vary in colour and are flattened on one side. When ripe the capsules dehisce and throw the seeds to a great distance, a point which has to be noted in connection with harvest. Owing to the poisonous nature of the castor seeds which contain 'ricin' the blood coagulant, it is not safe to allow the crop to ripen till the capsules dehisce, especially when it is grown adjacent to some other fodder crops. The seeds on pressing give nearly 50 per cent of oil, and this varies with the place of origin of the seed as follows :—

		Per cent.			Per cent.
Uganda	..	48—50.8	Rhodesia	..	39.6—52.2
Sudan	..	41—48.7	Fiji	..	47.4—49.6

Cultivation, Harvest, etc.—As a rule all places suited for the cultivation of maize are suitable for cultivating castor. It is easily sensitive to frost, and places where the summer is sufficiently long are well-suited. It grows from the sea-level up to a height of 5,000 feet. Sufficient rainfall is necessary till the roots establish themselves but afterwards very little is required. The soils that are best suited are well-drained sandy or clay loams. In India alluvial soils and red soils at the foot of the hills are also well-suited. Soils which are poor in organic matter require manuring with sheep or cattle manure. Even in India which stands first as regards the world's supply of castor seed and oil, the crop is seen growing here and there either in mixtures with legumes,

etc., or as a border crop for sugarcane and cotton. More often, it is seen cultivated in the backyards, waste places, manure heaps, etc., which are in the vicinity of the ryot's houses.

Since the crop is deep-rooted, deep ploughing is necessary and this in India is generally done in cold weather to eliminate all grubs, eggs of insects, etc., which are carried away by birds as the crop is often badly infested with these insects.

There are two distinct varieties of seed, *viz.*, the large and the small, 28 of the former or 55 of the latter go for an ounce, and the seed-rate can thus be easily calculated. The spacing between the rows and between the plants depends on the kind of seed used. If the small seeds are used, a spacing of 3 feet between the rows and 18 inches between the plant is required. In some cases preliminary soaking of the seed in water for 24 hours is recommended to soften the seed-coat, and facilitate germination. In India the large-seeded variety is sown during the monsoon rainfall in small patches in gardens, whereas the small-seeded one is used on a field scale at the end of the monsoon. Very little attention is needed after sowing except it be by way of a little inter-cultivation to remove weeds and conserve moisture.

The crop, depending on the variety sown, comes to harvest in 7 to 10 months if it is large, or 4 to 5 months if it is small. The capsules before they dehisce should be collected once a week and carried to a shed which is protected on all sides to prevent the escape of the seeds by the dehiscence of the capsules. The shed should be so constructed as to allow good sunshine and ventilation. On heaping for a time all the capsules dehisce and the shells are separated from the seeds by winnowing. The produce is then ready for marketing and should be properly stored. A good crop gives the following quantities of yield per acre depending upon the place and the climatic conditions:—

	Lbs.		Lbs.
India (mixed crop) ..	250	India (pure crop) ...	500—900
United States of America	900—1,350	Ceylon	800—1,200
Queensland	1,000—1,600	Egypt	1,000

Pests.—There are a good number of insect and fungoid pests and they can be controlled by spraying with copper sulphate or Paris Green or by hand picking.

Utilization of Castor Seed.—The seeds contain 20 per cent husk and 80 per cent kernel. The whole seed gives 46-53 per cent oil and the kernel 58-66 per cent. The seeds contain a blood coagulating toxin 'ricin', and synthesising facts. The large-seeded varieties give prolific yield of seed, whereas the smaller ones give less oil. The seeds are

mostly used for the preparation of oil and as a source of *lipase* which is employed in the fermentation process of fat-splitting.

Preparation of Oil.—In India the methods of extracting oil are more crude compared to those employed in Europe and as such the export of oil from India has very much diminished, the seed itself being exported in very large quantities.

EXPORTS FROM INDIA.

Year.				Castor Oil Gallons.	Castor Seeds Tons.
1879-80	..	..	..	2,651,889	11,880
1889-90	..	..	..	2,664,990	44,731
1908-09	..	..	..	1,099,967	82,523
1928-29	..	..	..	538,652	121,346

There are two distinct methods of extracting the oil, *viz.*, the cold and the hot drawn. The cold drawn oil is clear and colourless and is used only for medicinal purposes. For the preparation of this, choicest seeds are taken and the husk removed after which it is pressed at a temperature not exceeding 90—100° F. By this method 33 per cent of oil is obtained which is free from the poisonous principle 'ricin'. The cake obtained is then broken and is either pressed at a higher temperature or extracted with an organic solvent like Benzol which gives a deep yellow or brown coloured oil, inferior in quality. This is only for technical purposes. In Britain the oil is treated with live steam to remove the albuminoid matter by coagulation. In America it is heated under ordinary atmospheric pressure or under reduced pressure by closed steam coils to remove moisture and then bleached by heating at 200°F. with 2—4 per cent Fuller's earth. The cold drawn oil is not acidic and hence no addition of lime is necessary. Broken seed or seed which has been decorticated and kept for a long time should not be used for extracting the cold drawn oil, as the enzyme, *lipase*, present liberates the free acids from the oil present.

Properties of the Oil.—The physical and chemical constants are as follows :—

Specific gravity at 14.5° C.	..	..	0.959 to 0.969.
Refractive Index 40° C.	..	..	1.4679 to 1.4723.
Viscosity (Redwood) secs. at 100°F.	..	..	1160 to 1190.

Optical Rotation (200 mm.)	..	..	7.5 to 9.0.
Acid value	..	..	1.0 to 20.0.
Saponification value	..	..	176 to 186.
Iodine value (Wif's)	..	..	80 to 90 per cent.
Unsaponifiable matter	..	..	0.3 to 0.8.
Acetyl value	..	..	148 to 151.

The oil contains Glycerides of Ricinoleic, Oleic, Linoleic, Stearic and Di-hydroxi-stearic acids, but the characteristic properties of it are due to Ricinolein only.

USES OF CASTOR OIL.

- (1) Cold drawn oil is used as a medicament.
- (2) The most important use is as a lubricant in internal combustion engines and especially for aero-engines for which it is particularly suited owing to its remaining in a liquid form at low temperatures and retaining its viscosity at high ones.
- (3) It is used for preparing Turkey-red oil in the dyeing industry.
- (4) By heating it at atmospheric or reduced pressures at 300° C. for several hours it is converted into a polymer which is soluble in mineral oils and is used as a lubricant.
- (5) By heating the oil with sulphur or sulphur chloride at a high temperature, rubber substitutes are formed.
- (6) It is not much used in the preparation of soaps as they are not easily salted out. Only a few transparent soaps are prepared with it.
- (7) Other minor uses are in the preparation of 'cognac oil' flori-cin, artificial leather, cutting oils, linoleum, wood oil and as an illuminant.

Use of Castor Seed as a Hydrolytic Agent.—The lipase contained in the seed is industrially used for the splitting up of oil into Glycerine and Fatty acids and the latter are used in the preparation of soaps. The seeds are decorticated and the kernels macerated with water to form a thick paste. This is centrifuged to separate the seed particles from the emulsion, and allowed to remain at 23° C. for a day or two when fermentation sets in, and the emulsion separates into an aqueous layer and an upper layer of the consistency of thick cream. The aqueous layer consisting of an aqueous emulsion of Castor Oil, fatty acids holding the lipase in suspension, is used for hydrolysis.

The oil or fat to be hydrolysed is boiled well with dilute sulphuric acid and washed. This is then treated with half its weight of water and 7 to 10 per cent of hydrolytic agent obtained above in wooden vats which

are provided with perforated copper coils at the base to admit air for agitation. A small quantity of Manganese sulphate (0.2 per cent.) is also added as a catalyst. The liquid after agitation is allowed to remain for a day or two till the hydrolysis is complete, and this depends on the activity of the enzyme. After hydrolysis is complete the emulsion is broken up by agitation, and also by adding a small quantity of sulphuric acid if necessary. The whole solution will settle down into 3 layers, the top one containing fatty acids, the bottom glycerine and water, and the middle a mixture of water, albuminoid matter, glycerine and water. The bottom and top layers are separated, and the middle one treated with sulphuric acid to recover some more of fatty acids. The top layer consists of fatty acids which are of a pale colour, and good in quality, and these after washing well are used in the preparation of soaps.

Uses of the Castor Cake.—Because the cake contains the poisonous principle ‘ricin’, it is not used as a cattle food but only as a manure. Attempts were made to remove the ‘ricin’ by treating with salt solution and also by steaming, and even then the farmers do not patronise it, and are not prepared to take the risk. The composition of the cake varies with the method of pressing, and whether the seed is decorticated or not.

COMPOSITION OF CASTOR CAKE.

			From whole seed. per cent	From de- corticated seed. per cent	Castor seed meal ex- tracted by solvents. per cent.
Moisture	..	..	9.85	10.38	11.75
Ash	..	..	15.02	10.50	6.05
Oil	..	..	5.25	8.75	1.10
Protein	..	..	20.44	46.37	30.62
Fibre (Carbohydrates)	..	..	49.44	24.00	36.52
P ₂ O ₅	..	..	1.62	2.26	13.96

Exports and Imports of Castor Seed and Oil.—Regarding trade movements, India has been and still ranks first as chief source of supply of oil and seed in the whole world. Due to the primitive methods of expressing oil which are still in vogue in the country, the demand for it has considerably decreased giving place to the export of seed in enormous quantities, as will be seen from the tables below ;—

EXPORT OF CASTOR OIL FROM BRITISH INDIA.

Country to which exported.	1923-24 Gallons.	1924-25 Gallons.	1925-26 Gallons.	1926-27 Gallons.	1927-28 Gallons.
United Kingdom ..	296,261	219,122	320,647	467,215	264,486
Ceylon ..	23,495	26,257	30,820	24,016	31,295
Straits Settlements ..	19,546	20,048	23,169	22,223	17,439
Union of South Africa ..	50,567	43,989	57,392	33,912	58,866
Mauritius and depend- encies ..	24,504	33,874	30,220	26,070	22,715
Australia ..	58,534	36,567	34,999	16,104	15,542
New Zealand ..	64,013	35,799	72,625	24,589	21,804
Germany ..	28,581	68,679	81,141	24,016	16,811
Others ..	15,829	13,140	48,073	8,969	25,493
Total ..	581,330	497,475	699,626	647,114	474,451

EXPORT OF CASTOR SEED FROM BRITISH INDIA.

Country to which exported.	1923-24 Tons.	1924-25 Tons.	1925-26 Tons.	1926-27 Tons.	1927-28 Tons.	1928-29 Tons.
United Kingdom ..	14,780	24,668	29,930	22,883	32,540	25,552
Belgium ..	6,783	4,855	6,255	4,645	7,695	7,662
France ..	18,684	16,513	17,774	18,245	16,462	15,139
Spain ..	1,850	2,851	2,575	2,025	2,400	2,175
Italy ..	5,765	12,347	7,892	7,594	10,393	9,702
United States of America..	35,673	32,181	43,860	43,731	49,291	56,074
Others ..	1,495	2,033	1,502	2,425	2,930	5,042
Total ..	85,030	95,448	109,788	101,548	121,711	121,346

How far other countries like United Kingdom and America are dependent on India for this produce will be seen from the following tables :

IMPORT OF CASTOR SEED INTO UNITED KINGDOM.

Country from which imported.	1924 Tons.	1925 Tons.	1926 Tons.	1927 Tons.	1928 Tons.
British India ..	22,564	28,768	25,687	30,372	35,519
Belgium ..	263	29	345	1,060	17
Brazil ..	1,135	383	388	1,368	106
Others ..	2,037	776	752	2,467	1,214
Total ..	25,999	29,956	27,172	35,267	36,856

IMPORT OF CASTOR SEED INTO THE UNITED STATES OF AMERICA...

Country from which imported.	1924 Tons.	1925 Tons.	1926 Tons.	1927 Tons.	1928 Tons.	1929 Tons.
British India	31,855	37,669	40,336	48,818	..	..
Brazil	3,245	8,820	4,502	5,733	..	..
Hayti	204	472	66	39	..	..
Others	2,632	910	144	302	..	..
Total	37,396	47,871	45,048	54,892	..	..

Conclusion.—From the above figures it is more than evident that India plays a great part in the export of this valuable product, and in spite of the inherent difficulties felt in the harvest of the crop as already pointed out, it seems to pay the ryots even if grown on a small scale, particularly when the marketing of the material is undertaken on a co-operative basis. Attempts should also be made to extract oil by improved methods as in other countries, thereby exporting the oil only and retaining the cake which is a valuable manure. (Extracted from a recent Bulletin of the Imperial Institute, London)—*The Madras Agricultural Journal*, Vol. XVIII, No. 7.

Ensilage.

Since some confusion exists in the use of the terms silage and ensilage, the suggestion of Mr. Jenkins in his report to the Royal Agricultural Society in 1884 has been adopted: "That the word ensilage should only be used to describe the process and that the product should be called silage."

Ensilage is the process whereby crops are preserved in a green state by the exclusion (or limitation of supply) of the oxygen in the air from the silage material.

VARIETIES OF SILAGE.

It has been found possible to differentiate no less than five distinct types of silage :—

- I. Sweet, dark brown silage.
- II. Acid, light brown or yellow silage.
- III. Green fruity silage.
- IV. Sour silage.
- V. Musty silage.

I. Sweet, dark brown silage.—This silage is produced when the temperature rises above 113°F. and not above 130°F. The main condition to which the production of this variety is due is the facilitation of

fermentation by the presence of sufficient air so that the temperature rises above 113°F. Conditions contributing to this are :—

- (a) A comparatively dry crop, *i.e.*, one that is fairly mature or has been allowed to dry somewhat after cutting. Such a crop facilitates fermentation as it does not pack so closely, thus permitting the air to penetrate the silo readily and because the heat which is generated by fermentation has comparatively less moisture in the silage to heat and consequently the temperature rises more.
- (b) The temperature must rise to 113°F. and to obtain this, intermittent stacking or ensiling is generally necessary. First fill 3 or 4 feet of the silo, wait till the temperature of the first-layer will rise to above 120°F., and then the second layer will weigh down the first, and the temperature will only rise another degree or two.

When a pit of silage made in this way is opened, it will probably contain three different varieties of silage :—

- (a) The top layer of 6 inches to a foot will be mouldy. The reason for this is that too much air has entered and in consequence the temperature has risen too high and excessive fermentation has taken place.
- (b) The main portion will consist of sweet dark brown silage.
- (c) At the bottom of the pit there will be a small quantity of sour silage. The formation of this is due to juice having been pressed out under pressure and to the exclusion of air, when oxidation is followed by a breaking down of proteins and the liberation of butyric acid.

Sweet silage is a good—though not the best—form of silage and has a sweet pleasant smell like that of over-heated hay. It is generally comparatively dry and readily eaten by stock, but owing to excessive fermentation it has lost more digestible food materials than other forms and is therefore somewhat wasteful to make.

On Military Grass and Dairy Farms, the production of this type of silage should be aimed at, particularly when ensiling monsoon grasses.

II. Acid, light brown or yellow silage.—In order to obtain this variety of silage, the crop from which it is made should be fairly ripe or dry before ensiling and should contain from 25 to 30 per cent of dry matter. The temperature must not rise over 104°F. and may remain as low as 85° or 86°F. In making this type of silage very little juice is expressed.

This variety of silage has a yellow-brown to brown colour, and has an acid though pleasant smell, due to the presence of acetic acid (vinegar). It is palatable and readily eaten by stock but when fed in large quantities causes the teeth to loosen and decay.

III. Green fruity silage.—This is probably the best type of silage but is extremely difficult to make, although there are records of its having been made before the days of tower silos. Oats and vetches made the best silage of this type and the crop must be cut in a medium stage of maturity, the oats being in full milk, and in the case of vetches the pods should be well formed without seeds having formed in the lowest pods. The maximum temperature should not rise above 86°F. as, if it rises higher than this, an acid silage will be made. The crop must also be cut and ensiled on the same day.

This type of silage has a green to olive-green colour and a smell that is delicious, neither sweet nor sour but best described as “fresh” or “fruity”. It is a most nourishing and palatable form but suffers from one practical disadvantage, *viz.*, large quantities of juice, containing soluble food material, are liable to be pressed out and drained away from the freshly cut and barely mature crop. This liquid contains a certain amount of digestible products (amid nitrogen) and a good deal of sugar and will easily ferment. It has been collected and fed in a fresh condition to cattle and pigs with advantage.

IV. Sour silage.—Sour silage has generally a very dark-brown or olive-brown colour with a peculiarly pungent and unpleasant smell largely due to the presence of butyric acid. It is commonly made when a very immature crop is cut and ensiled in that state, when it packs very closely and excludes the air so that little heating is possible. The temperature may not rise above that for green fruity silage. In a wet year, the production of sour silage may be obviated or the sourness reduced, by filling the silo very slowly, so that oxygen is not excluded and a certain amount of heating takes place in each layer before the next is put on.

Another form of sour silage may occur when a laid crop, having become partially rotten at the base, is ensiled, and especially if after cutting, rain falls and rotting proceeds in the fields. This putrefaction appears to continue in the silo and a very evil smelling silage may result. If such conditions prevail and the crop after cutting has begun to get rotten, it is desirable to let the surplus water dry off the crop before it is ensiled.

V. Musty silage.—Often a musty silage is produced, when conditions have been such as to produce a good type and the eventual produ

is covered with fungus and practically useless. Silage of this type has been produced when an over-mature crop has been cut and allowed to dry in the fields for 24 hours. The consequence then is that the chaffed fodder is very porous and instead of normal fermentation, a large number of mouldy spots are produced and by their growth cause the silage to have a musty and ammoniacal smell. When, for any reason a crop has been allowed to become over-mature before cutting, it should on no account be allowed to dry in the fields but should be ensiled at once.

SUITABLE CROPS.

Almost all kinds of herbaceous crops are capable of being made into good silage with the exception of the Brassicæ plants of the cabbage tribe, which are too succulent, give rise to obnoxious smelling silage and are generally unsuitable. Although many crops can be converted into silage, it does not follow that all are equally suitable, nor that good silage can be expected if any old rubbish is put into a silo.

An ideal crop for ensilage should fulfil the following conditions :—

- (i) Be easy and cheap to grow so that its cultivation does not interfere with that of other more important crops. If it comes to maturity, *i.e.*, fit to ensile, at a time when other crops do not demand attention, so much the better.
- (ii) It should be a reliable crop, not given to great variations in yield.
- (iii) It should be easy to harvest, capable of being cut by mowers, easily carted and quickly chaffed for filling the silo.
- (iv) It should quickly reach the necessary degree of maturity for ensiling, since immature silage is liable to sour.
- (v) The silage produced should have a relatively high food value, should be digestible and contain a reasonable amount of albuminoids.
- (vi) Lastly, it should allow time for weed destruction before sowing or after harvesting.

The chief crops which are used for silage in India are :—

- (i) Coarse grasses such as Burroo.
- (ii) Maize.
- (iii) *Churree*.
- (iv) Cats.

Coarse grasses.—All kinds of grasses are capable of being made into good silage. In bad weather the first cutting of grass can be made into silage. Burroo, if cut at the right period, makes excellent silage, but it must be borne in mind that it matures very quickly so that the stalks become fibrous and indigestible. This grass usually, where prevalent,

grows luxuriantly, can be cut by mowers and presents little difficulty in handling.

Maize.—Maize has undoubtedly, when regarded from the world point of view, proved of the greatest value for silage, and where it can be grown it produces a splendid silage crop; heavy, very nutritious, easy to cut and handle, and producing excellent silage.

Various legumes, such as *lobia*, produce a bulky crop of digestible nutritious food, containing a high proportion of albuminoids and require little preparation of the seed-bed. As the stems are weak, they are incapable of holding the plant erect, and therefore require to be grown with a supporting crop such as maize.

Churree.—This crop—like maize—produces a heavy nutritious crop, easy to cut and handle and makes excellent silage.

Oats.—Oats by themselves make an excellent variety of silage, but in England when grown for this purpose, are usually sown with tares or vetches.

TIME TO CUT.

A crop suitable for silage making is one that is ready at a time when other farm work is at a minimum, so that the cutting and ensiling can be carried out conveniently.

Apart from this, considerations which are taken into account in deciding when to make silage are chiefly associated with the maturing of the crop.

As a crop grows, it is at first very succulent and digestible, contains very little fibre and yields a small crop; if cut too young before coming into ear, not only is the weight small, but the crop is likely to result in the production of sour silage. Sometimes a crop becomes "laid" before coming into ear, but it is unwise to make such a crop into silage, unless very special precautions are taken, because very sour silage is likely to result.

As the crop comes into ear, flowers, sets and matures its seed, the stems and foliage become less succulent and digestible, with the formation of fibre and the transference of food material to the seed. In the case of cereals this process is more complete and more sudden than with other crops.

The result is a gradual and continuous increase in the total dry weight and food value of the crop right up to the time the crop is fully ripe, so that it is desirable to allow the crop to become moderately mature before it is ensiled. If the crop is not sufficiently mature, the silage will be unable to retain all the juice of the watery immature crop, so that

it will be pressed out, and may drain away and be lost with digestible food material in solution.

If the crop is allowed to become too mature, there is great danger of its becoming laid and rotten at the bottom of the stems and of the leafy portions being lost in cutting and carting.

Another point to remember is that if there are weeds in the crop, the crop should, if possible, be cut before the weeds become sufficiently mature to shed their seed during cutting and carting.

Generally speaking, it may be stated that a crop for silage should be cut in a rather more advanced stage of maturity than for hay making, because not only is the loss of foliage during carting very much less, but as the crop is ensiled very shortly after cutting, there is very little chance of any further formation of fibre.

HOW TO CUT.

As far as possible, especially when the crop is heavy, it should be cut by mowing machines.

One other point should be considered here, *i.e.*, the time of cutting in relation to carting and ensiling. As has already been pointed out, the quality of the silage depends, amongst other things, upon the interval of time between cutting and ensiling. The best type—"green fruity silage"—is likely to be obtained from a moderately mature crop which is ensiled immediately after cutting. Acid silage is likely to result if the crop is allowed to become partially dried after cutting, while sour silage will be produced from a crop cut and exposed to rain for some days, so that decomposition commences in the field before ensiling.

It is therefore desirable to cut each day just so much of the crop as can be carted and ensiled the same day, leaving only sufficient uncartered at night to provide for work the next morning.

CARTING AND CHAFFING.

The handling of the green crop, both in loading the carts and feeding the silage cutter, entails heavy labour and careful attention should be given to planning the operations. Again the labour of feeding the cutter is rendered easier if a sloping platform has been erected by the side of the chaff cutter, so that the green crop, when pitched from the carts upon this, can be easily drawn down and fed to the cutter.

FILLING THE SILO.

In making silage in whatever type of silo, the general principles are the same. Ensilage is the preservation of a green succulent crop by the exclusion or limitation of supply of the oxygen in the air from the silage material. Access of air to a heap of succulent green material results,

in the first place, in fermentation, with the slow burning and loss of digestible food substances and the production of heat. Therefore, in making silage, one of the objects is to limit fermentation by excluding air. If air has access to the silage for a continued period, as by cracks in the wall of the silo, then normal silage fermentation is followed by the growth of moulds and the silage is spoilt. Before the silo is filled care must be taken to see the walls are air-tight and in filling, air must be excluded as far as possible by efficient trampling.

TOWER SILOS.

In the actual filling, the crop after being chaffed is blown to the top of the silo and then falls into the silo through a shoot which can be directed to all parts of the silo for distributing the chaffed green crop. The silo should be filled regularly and uniformly and as each layer of green chaff is spread out it should be uniformly trampled. It is not infrequently stated that, in filling the silo, the silage should be kept highest at the walls and lowest in the centre, and that the silage should be trampled more tightly at the sides than in the centre. It will be seen, however, that if this is done, the centre will settle more rapidly than the sides and silage will tend to fall away from the sides to the centre and so allow access of air and consequent mould formation on the exposed silage next to the wall. It is better to keep the surface level or slightly highest in the centre, and to trample the whole uniformly at the sides and centre so that the whole settles regularly, and the silage is kept tightly pressed against the walls and air is excluded.

At the commencement of filling it is not necessary to trample the silage very heavily because the layers of silage added later will rapidly effect this automatically. At this stage one man will be sufficient for trampling. As the silage nears the top of the silo, two or three men will be needed because efficient trampling at this stage will not only increase the capacity of the silo, but will also tend to reduce the heating which is apt to be unnecessarily high at the top.

Another factor which helps to determine the effective capacity of the tower silo is the time over which filling takes place. If filling is very rapid, then no matter how efficient the trampling, the whole contents will continue to ferment and settle over a period of several weeks, so that before the silage is issued, the top one-third or more of the silo will be empty. This may be obviated to some extent if the period of filling is lengthened so that silage in the lower and middle parts of the silo has time to ferment and settle before the filling of the silo is completed.

If a silo, filled to the brim at the end of the week, is left over the week-end, it will be found that the silage has settled and there is room for further filling. When such intermittent filling is practised the interval between any two fillings should not exceed 60 hours or it will be found that a mouldy layer has formed on the top which will persist in the silage. It is at the top in a tower silo where most spoilage and wastage is likely to occur and some waste is inevitable. Under good conditions no more than 6 inches should be spoilt but with careless management as much as 3 feet may be wasted. Care should be taken that the last 10 to 15 loads are ensiled in a very succulent condition and not half-dried as is sometimes the case. If at the end of filling, the crop is over-mature and dry, water may usefully be added by turning a hose pipe on to the green crop as it passes into the chaff cutter. This adds to the weight and pressure on the top and enables the silage to be packed more closely.

PIT OR CLAMP SILOS.

The making of silage in a tower involves considerable capital expenditure, while pit silage can be made without such heavy cost.

It must not be thought that silage can be made in a pit without care, for there are at least two important dangers to be avoided :—

- (i) Wastage on the top and sides of the pit which may be excessive when conditions are bad, *i.e.*, up to 25 per cent or more. This wastage is higher proportionately in a small pit than in a big one, because the proportion of exposed surface is relatively larger in the former.
- (ii) The fact that silage in the lower part of the pit is liable to be very sour due to the carts being drawn over and to the difficulty of access of air to this part of the pit owing to the impervious earthen walls.

The site.—The site should be selected with care and the following points must be considered :—

- (i) Where the silage will be fed, *i.e.*, if required for issue to units or for farm animals. In the former case, it will be economical to place it in the corner of a plot, in the latter, in a convenient position close to where it is required.
- (ii) The site selected must be convenient of access and close to a road to permit of carting in bad weather.
- (iii) The site must be such that the bottom of the pit is not subject to flooding during the rains.

If the pit is to be permanent it may be from 3 feet to 7 or 8 feet in depth according to circumstances, but if "long" silage is to be made it should not be so deep as to prevent carts being drawn over it.

The sides should not be quite vertical but should have slight slope inwards to the floor of the pit which will help to support the sides and also provide for more perfect packing of the silage.

The shape and size of the clamp depend upon several factors :—

- (i) Whether the silage is long or chaffed.
- (ii) The estimated daily issues.
- (iii) The amount of silage to be made.

(i) When silage is chaffed a circular pit can be made, but this has the disadvantage, when issues are small, that too large a surface of the silage will be exposed and the exposed portion will have begun to decay before being used.

For 'long' silage an oblong pit is preferable, and the width should be sufficient to allow loaded carts to be led over the pit when it is being made without toppling over.

(ii) The width of the pit should be such as to admit of a section being cut which will provide issues for not more than two or three days. If the width is too great, the period between the cutting of each section will be too long and the exposed face of the silage will have begun to decay before being used.

(iii) The length of the damp will depend upon the amount of crop to be ensiled. In calculating the weight of silage it may be taken as varying between $\frac{2}{3}$ and $\frac{3}{4}$ of the weight of the green crop concerned. Having obtained an estimate of the weight of silage to be pitted, this must be divided by 40 to convert pounds of silage into cubic feet since 1 cubic foot of silage weighs on the average 40 lbs. The height to which a pit of silage will ultimately settle will depend upon a variety of circumstances but especially on the time taken to fill the pit.

Filling the pit.—As has already been pointed out, unless precautions are taken, the silage in the bottom of the pit is subject to excessive pressure and when other conditions are favourable, *e.g.*, a damp succulent and perhaps immature crop, sour silage results. Sour silage may be prevented by allowing the fodder at the bottom of the pit to wilt for a couple of days before carting, in which case the crop will be drier and lighter when carted. The pressure on the pit being in consequence less, the air has readier access, more heat is generated by fermentation, the temperature rises to a higher degree in the drier materials and sour silage is prevented from forming. Alternatively the first day's work on the pit may be stopped when a depth of only 2 to 3 feet of silage has

been pitted, and the pit left for a couple of days when considerable heating will result since it will not be too closely compacted. With this heat below, the building of the rest of the pit can be steadily pushed forward and it will be found that silage will heat normally.

With chaffed silage the filling of the pit should follow similar lines to filling a tower silo.

With long silage, each loaded cart of green crop is led over the pit, tipped off behind and the green stuff roughly spread.

In building the pit the sides above ground should slope slightly inwards, but this must not be exaggerated because as fermentation proceeds and successive layers of green crop are added the pit will settle greatly and consequently the slope of the walls will be increased.

The building of the pit should preferably be continued intermittently over a period of not less than eight days, in order to give time for the several layers of silage to ferment and settle down, so that the heap of silage when completed may have a considerable height. The height of the pit above ground can never be carried much more than 7 feet above ground level at any time on account of the danger of the carts over-turning. When intervals are allowed in the pitting, these should not be greater than two clear days lest moulding should take place on the exposed surface.

Covering the pit.—There is danger of overheating and excessive dryage of the top layer, as in the tower silo, and this can be obviated by using very succulent material on the top or better still by the use of some succulent waste material, if available. It is most important to obtain the right shape to the top in order that the greater part of the rain water can be shed by the slope of the roof: otherwise the water tends to soak in the pit and leads to the decay of much silage at the eaves. For this reason the side walls as built, should slope inwards and in completing the roof this process must be continued and accentuated by heaping up the centre by hand after the sides have been so drawn in, that it is no longer possible to cart with safety over the pit.

When the last load has been carted upon the pit, a short part only of the toe of the run up at either end should be cut off leaving a considerable slope and the material pitched upon the sloping ends of the pit, otherwise the greater part of the toe will be spoilt before the silage is used.

In actual covering with earth, the first precaution to take is to commence covering immediately the pit is complete, because delay means additional wastage. In covering, instead of building up from the sides, the earth should first be thrown on to the centre of the top of the

pit. The reason for this is that the pit is continually settling, and if the earthing up is started at the bottom, a sort of arch will be formed over the top which partially supports itself and prevents the compacting of the heap. The difficulty in this covering is that the soil keeps rolling off the eaves, but this is overcome by slinging large poles about 4 or 6 inches in diameter, on either side of the eaves of the pit by means of wire passing over the heap.

The soil lodging on these poles is prevented from rolling off, and a covering is quickly effected; moreover, the greatest thickness of soil will be just above the eaves where the greatest pressure is desirable. Another advantage of this method is that the pressure of the soil is immediately applied to the top of the pit which rapidly settles down, air is excluded and excessive heating of the top layer is prevented.

The best depth of earth covering is probably 12 inches; a smaller depth is often adopted in practice but this leads to greater waste. The diagram shows a section of a pit which has been covered with earth as described and allowed to settle.

It is a matter of opinion when the top of the pit is covered whether the sides of the pit should be earthed in. This is generally done, though mechanically it can exert but little pressure, and may, as already stated, even tend to lessen the pressure. It seems probable that earthing the sides is unnecessary.

Wastage.—It must always be realized that the making of pit silage is liable to lead to excessive wastage by moulding and decomposition unless suitable precautions are taken, and that this wastage is progressive, *i.e.*, the longer the silage is kept, the larger the wastage.

In one case where the clamp was covered with 12 inches of earth directly after filling was completed, and the green stuff was well packed the wastage on account of mouldy silage on top amounted to 5.7 per cent. In other case where the pit was not so well packed and covering of earth was only 6 inches, which was put on two or three days after the pit was completed, the wastage in six months on account of mouldy silage amounted to 19 per cent.

—*The Journal of the Central Bureau for Animal Husbandry & Dairying in India*, Vol. IV, Part I.

ules for the Affiliation of Moffussil Agricultural Associations to the Mysore Agricultural and Experimental Union as passed at the Special General Meeting on the 15th November 1930.

Any moffussil Agricultural Association in the State may, on application, be affiliated to the Mysore Agricultural and Experimental Union on approval by the Managing Committee and subject to the following :—

1. The Affiliated Association shall have on its roll at least 25 members paying an annual fee of Rs. 3 at the time of application.

2. The aims and objects of the Affiliated Association shall be in conformity with those of the Mysore Agricultural and Experimental Union.

3. Each Affiliated Association shall pay to the Union an affiliation fee of Rs. 5 and an annual minimum subscription of Rs. 10.

4. Each Affiliated Association shall be entitled to have two of its representatives in the General Body of the Union, these representatives having all the privileges of membership in the Union. It shall also be entitled to a free supply of two copies of the Journal of the Union.

5. Each Affiliated Association shall likewise be entitled to return two of its representatives and to the free supply of two copies of the Journal for every additional annual subscription of Rs. 10.

6. Each member of an Affiliated Association shall be entitled to have a copy of the Journal of the Union at a concession rate of Rs. 2 per annum through the local Association.

7. Such of the members of the Affiliated Associations as are not members of the Union may attend, take part in the discussions at the General Meetings of the Union, undertake experimental work on behalf of the Union as provided for by it, but shall have no power to vote, stand for any election on behalf of the Union or to move or second any resolution.

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